

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of
Inventor(s): Mills

Group Art Unit: 1745

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App'n Ser. No.: 09/008,947

Examiner(s): Kalafut for the Secret Committee

Filing Date: 01/20/1998

Title: HYDRIDE BATTERY AND FUEL CELL
* * * * *

RESPONSE TO OFFICE ACTION

Hon. Asst. Commissioner of Patents and Trademarks
Washington, D.C. 20231

April 16, 2003

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Sir:

Applicant files this paper in response to the Office Action dated October 17, 2002.

In that Office Action, the Secret Committee responsible for examining the present application erroneously rejects all of the pending claims 1, 2, 4-6 and 10-59 under 35 U.S.C. §§ 101 and 112, first paragraph, devoting just one paragraph to address the merits of Applicant's prior 500-plus- page Response, dated August 7, 2002. That Response detailed the numerous problems pervading the Committee's prior Office Actions, including its failure to: (1) identify all persons working for, or involved with, the Committee in withdrawing or rejecting pending BlackLight Power applications; (2) identify those persons responsible for analyzing the vast body of experimental evidence demonstrating the existence of lower energy states of hydrogen and, based on that analysis, for deciding whether to issue Applicant his patents; (3) establish consistent patentability standards and guidelines by which that patentability decision is to be made; and (4) properly analyze the evidence of record—now published, or to be published, in over 50 peer-reviewed journal articles—that the Committee required Applicant to submit.

The Secret Committee merely perpetuates these problems in its October 17 Office Action by anonymously dismissing, without analysis, Applicant's most recently submitted experimental evidence, which it mischaracterizes as "cumulative to that already of record." Ironically, that mischaracterization only further admits the Committee's total unfamiliarity with the record evidence and, thus, its obvious failure to seriously consider it.

Frustrated by the Secret Committee's inaction, but still determined to get a fair hearing, Applicant requested and received the courtesy of a personal Interview, held February 11, 2003,

to present his evidence. Applicant thanks Examiner Wayne Langel for arranging the Interview and for making of record his consistent view that Applicant's novel hydrogen technology is fully operable and, therefore, entitled to patent protection. Applicant also thanks Examiner Kalafut and the other PTO officials in attendance, especially the new official introduced at the Interview, Quality Assurance Specialist Douglas McGinty, who led the PTO team.

During the Interview, Applicant made a sincere effort to advance the prosecution of his applications and to find common ground upon which all of these cases, once again, would be allowed to issue as patents. Applicant believes it was a worthwhile effort given the following agreements reached between Applicant and lead-Specialist McGinty:

- (1) Applicant will identify the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties;
- (2) the Examiners whose signatures appear on the rejections of record, *i.e.*, Examiners Langel, Kalafut, and Wayner, have full authority to review that data and, based on their review, to issue patents as deemed appropriate; and
- (3) Applicant will confer with the signatory Examiners, either by telephone or in person, to review each assigned application on a claim-by-claim basis to ensure that the scientific data presented adequately supports the scope of the claims. For those claims determined to be adequately supported by the data, a patent will issue. For any claims deemed to be inadequately supported, Applicant reserves the right to continue seeking that broader claim coverage in subsequent proceedings.

Applicant appreciates the guidance Specialist McGinty provided during the Interview for securing his patents. Based on that guidance, Applicant presents the following additional comments detailing the substance of discussions held at the Patent Office on February 11th and identifying the independent, third-party data per agreement (1).

These comments confirm the operability of Applicant's novel hydrogen technology as originally found by Examiner's Kalafut and Langel in previously allowing six of BlackLight's patent applications (including this one). Thus, Applicant respectfully requests that the Examiner exercise his authority to issue a Notice to that effect under agreement (2) so that a patent may now issue.

A Brief Prosecution History

To place the agreements reached at the February 11 Interview in their proper context, Applicant briefly summarizes below the PTO's past use of improper procedures to secretly examine this and other BlackLight applications. As documented in Applicant's previous Responses, ever since the Secret Committee took over this examination following the suspicious withdrawal of five previously allowed BlackLight applications, the process has been plagued by four reoccurring problems. [See Responses dated August 7, 2002, January 7, 2002 and March 1, 2001.]

One such problem has been the Committee's consistent failure to identify all of its members and other persons from within and outside the Patent Office who contributed to, or were otherwise involved in, withdrawing or rejecting BlackLight's applications, including this one. That information is absolutely critical, since it goes to the very heart of the credibility of the rejections being asserted against Applicant.

For instance, germane to this case is the identity of those persons involved in creating the substantive rejections of record, including: (1) the September 1, 2000 Office Action and attached 9-page Appendix (Paper No. 17); and (2) the July 5, 2001 Final Office Action with its 68-page "Attachment to Response to Applicants' Arguments" (Paper No. 25). Just as Specialist McGinty sought assurances at the February 11 Interview that persons involved in generating and furnishing the scientific data submitted by Applicant are independent and unbiased, Applicant deserves similar assurances that those involved in rejecting BlackLight's applications are also independent and unbiased. Despite Applicant's repeated requests for such assurances, none have been forthcoming.

Because of the importance of this withheld information to the prosecution of his cases, Applicant enlisted the help of five current and former U.S. Senators—Ron Wyden, Gordon Smith, Jon Corzine, Robert Torricelli, and Max Cleland—to force PTO officials to divulge that information. As detailed in prior Responses, these Senators were likewise stonewalled by the PTO, whereupon four Senators requested that Senator Patrick Leahy—then Chairman of the Judiciary Committee overseeing the PTO—and Commerce Secretary Donald Evans look into

this matter. [See Senators' letters and PTO responses (Attachments 64 and 65 filed with March 1, 2001 Response)].

The PTO's failure to provide this important information, despite frequent requests to do so, has only fueled suspicions that BlackLight's competitors—the American Physical Society (APS) and its chief spokesman/lobbyist, Dr. Robert Park, in particular—have been sabotaging Applicant's patent rights. Those suspicions were confirmed when Applicant discovered that Dr. Park has communicated with a PTO contact he refers to as "Deep Throat" with access to confidential patent information. Even after having been informed of this, the PTO continues to rely on Dr. Park as BlackLight's chief critic to justify the rejections of record, as recently as the February 11, 2003 Interview.

Dr. Park has basically admitted his involvement in BlackLight's patent affairs, as evidenced by a recent issue of *What's New* he authored and published on the APS website:

The status of BlackLight Power's intellectual property is fuzzier than ever. BLP was awarded Patent 6,024,935 for "Lower-Energy Hydrogen Methods and Structures," a process for getting hydrogen atoms into a "state below the ground state". . . . You might expect these shrunken hydrogen atoms, called "hydrinos," to have a pretty special chemistry. Do they ever! Indeed, a second patent application titled "Hydride Compounds" had been assigned a number and BLP had paid the fee. Several other patents were in the works. That's when things started heading South. Prompted by an outside inquiry (who would do such a thing?), the patent director became concerned that this hydrino stuff required the orbital electron to behave "contrary to the known laws of physics and chemistry." The Hydride Compounds application [the '294 application] was withdrawn for further review and the other patent applications were rejected. [September 6, 2002 Online Newsletter of Dr. R. Park, *What's New* (Attachment 83) (emphasis added)]

Dr. Park's startling admission was confirmed in a recent issue of the *Online Newsletter* published by the James Randi Educational Foundation (JREF), which, like Dr. Park, boasts of having contacted the Patent Office to sabotage applicants' patent rights:

But why, hard on the heels of re-examining other questionable patents (see three weeks ago on this page), would the Patent Office have happened upon this particular one [BlackLight's withdrawn '294 application], when there are so many in this category? The secret can be inferred from Bob Park's weekly column, where we find: "Prompted by an outside inquiry (who would do such a thing?) . . ." That rascal!

The very fact that the Patent Office has paid heed to the complaints that Park, the JREF, and others have made, speaks well for rationality. Let's hope that we can look forward to

many quack devices and systems being re-evaluated. Let's see a lot more of this "extraordinary action" from the Director. As for BlackLight Power, says Park, "Their long-awaited IPO may have to wait a little longer." [September 20, 2002 Online Newsletter of the JREF, *Swift* (Attachment 84) (emphasis added)]

Applicant has also made the PTO aware that Dr. Park's APS colleague, Dr. Peter Zimmerman, the former Chief Scientist for the U.S. State Department, published an Abstract of a proposed APS speech boasting how his Department and the Patent Office "have fought back with success" against BlackLight. [See Attachment 54C filed with March 1, 2001 Response]

If, as Applicant suspects, the PTO has conferred with anyone having ties to the APS, like Dr. Park or Dr. Zimmerman, or to other BlackLight competitors in withdrawing or rejecting BlackLight's applications, that information would be highly relevant and thus must be disclosed. Clearly, knowing the identity and potential biases of all persons providing input or otherwise involved in rejecting BlackLight's applications, especially those with competing interests, bears directly on the credibility of those rejections.

The second major problem confronting Applicant throughout this examination has been the Secret Committee's steadfast refusal to identify the person(s) having ultimate authority to analyze his scientific data evidencing the existence of lower-energy hydrogen and, based on that review, to issue patents on his novel hydrogen technology. The Committee's unfair refusal to divulge that information has also seriously handicapped Applicant's ability to respond to and overcome the pending rejections.

Knowing who is responsible for analyzing the record evidence would allow Applicant to assess that person's qualifications, as compared to those Ph.D. scientists who peer reviewed the published experimental evidence confirming lower energy states of hydrogen. Furthermore, by knowing who decides the ultimate fate of BlackLight's applications, Applicant can more easily ascertain and meet the patentability standards that are being applied against him.

This last point touches on the third major problem facing Applicant, namely, the Secret Committee's failure to apply consistent standards upon which it bases its patentability decisions. As explained throughout Applicant's prior Responses, the Committee has taken a "moving target" approach to patentability—each time Applicant meets one standard, the Committee simply raises the bar and sets a new one.

For instance, at an early stage of the proceedings, the Secret Committee accused Applicant's novel hydrogen technology, in theory, of violating known laws of physics and chemistry—without identifying a single law that is allegedly broken—and set a standard requiring Applicant to prove otherwise. When Applicant met that standard by demonstrating that the existence of lower-energy hydrogen is based on his classical quantum mechanics theory derived from first principles that successfully applies physical laws on all scales, from the atom to the cosmos, the Committee simply invented and applied new standards. These new standards included requirements that Applicant prove that his technology does not violate general beliefs in the scientific community, that he prove that quantum theory is invalid, and that he publish his confidential scientific data in peer-reviewed journal articles.

With all of these changing standards, the one constant has been the Secret Committee's avoidance of any serious analysis of Applicant's real-world scientific data proving the existence of lower energy hydrogen. Determined to force the Secret Committee to conduct that analysis and to set reasonable standards by which his data could be accepted as reliable proof, Applicant requested the courtesy of a personal Interview, which was held over two years ago on February 21, 2001.

As explained above, to effectively determine the standards being applied against Applicant, he first had to identify the person(s) responsible for setting those standards. Applicant, however, was only partially successful in that effort. Prior to the February 21 Interview, Applicant's counsel uncovered the identity of only one Secret Committee member, Examiner Vasu Jagannathan, who played a role in rejecting BlackLight's applications.

Incredibly, Examiner Jagannathan initially denied any such involvement, accurately noting that his name did not appear anywhere in the record. He therefore refused counsel's explicit request that he attend the upcoming Interview. Only after counsel wrote to a high-level supervisor demanding that Examiner Jagannathan attend did counsel receive confirmation that the Examiner was "directly involved in the creation of the Office Action" to be discussed at the Interview and that he would indeed attend. [See January 19, 2001 letter to Director Esther Kepplinger (Attachment 54 filed in March 1, 2001 Response) and February 12, 2001 Letter from Director Jacqueline M. Stone (Attachment 55 filed in March 1, 2001 Response)]

Examiner Jagannathan confirmed his direct involvement by leading the Interview discussions. The Examiner's participation afforded Applicant an opportunity to assess his qualifications to examine and evaluate the experimental evidence of record. Based on several comments he made, Examiner Jagannathan basically admitted he was unqualified to do so. For example, as documented in the Response filed after the Interview, when Applicant presented highly reliable spectroscopic data confirming the lower energy states of hydrogen, Examiner Jagannathan's claimed it was nothing more than "a bunch of squiggly lines."

When pressed for guidance on what standards he used to evaluate Applicant's scientific data and to decide whether to issue his patents, Examiner Jagannathan would not elaborate. Rather, he proposed a new standard requiring Applicant to submit and publish his data in peer-reviewed journal articles before he would give it serious consideration. Despite strenuous objections to this newly minted standard, Applicant nonetheless worked diligently to comply with it.

Over the subsequent two years, Applicant used vast resources to present experimental evidence of lower energy states of hydrogen—much of it generated by independent third parties—in over 50 peer-reviewed articles published, or soon to be published, in prestigious scientific journals, including:

- Applied Physics Letters;
- Chemistry of Materials;
- IEEE Transactions on Plasma Science;
- International Journal of Hydrogen Energy;
- Journal of Applied Physics;
- Journal of Molecular Structure;
- Journal of New Materials for Electrochemical Solutions;
- Journal of Plasma Physics;
- Journal of Quantitative Spectroscopy and Radiative Transfer;
- New Journal of Physics; and
- Vibrational Spectroscopy.

Despite this significant accomplishment, the Secret Committee, true to form, essentially ignored that published evidence as well, exemplifying the fourth and final problem permeating

the prosecution history of this and other BlackLight applications. Even during the recent February 11 Interview, PTO officials initially raised non-technical arguments to explain why lower-energy hydrogen supposedly cannot exist and therefore to justify ignoring real-world analytical studies that definitively prove its existence.

Applicant has raised this reoccurring problem in prior Responses, only to be ignored. On the odd occasion when the Secret Committee would address the record evidence, it would do so by nitpicking a tiny fraction of that evidence, usually having nothing to do with the conclusions to be drawn from it. For instance, the Secret Committee argued that the high-energy plasma demonstrated that hydrogen was going to a higher energy state without explaining how the plasma was formed in the first place. The Committee fails to recognize that the plasma is powered by the release of energy during the formation of lower-energy hydrogen, which process has been conclusively confirmed by the predicted emission from the catalysts, extraordinary line broadening of the hydrogen lines, excess energy, anomalous after glow radiation, novel spectral lines, sustained inversion of the hydrogen lines and novel lower-energy hydrogen containing compounds. As was normally the case, the Committee did not respond to, much less refute, Applicant's critique of its overly simplistic approach to that evidence or, as in most cases, its complete lack of analysis.

The Secret Committee refusal to address and solve the four problems outlined above have unfairly compromised Applicant's patent rights, which refusal continues in the present October 17 Office Action discussed below.

The October 17, 2002 Office Action

In the prior Response dated August 7, 2002, Applicant requested that the Secret Committee identify its members and other persons involved in creating the substantive Office Actions of record to force those persons to fairly analyze his scientific data using lawful patentability standards. Included in that Response was a detailed discussion of those issues, pointing out the fatal defects embodied in the Committee's prior Office Actions and submitting additional published scientific data to further satisfy Examiner Jagannathan's evidentiary requirement.

The Committee ignored Applicant's 500-plus-page Response and, once again, dismissed the data out of hand in a one-paragraph statement. While that statement claims that the experimental evidence submitted by Applicant was considered, the short explanation for its dismissal indicates otherwise:

The new extensive experimental evidence submitted by applicant has been considered, but is not convincing of error in the rejections. Such evidence is cumulative to that already of record, and the calorimetric, spectroscopic and plasma experiment data has been adequately addressed in sections 19-25 in the ATTACHMENT TO RESPONSE TO APPLICANT'S ARGUMENTS which was a part of Paper No. 20. See particularly section 24 of such attachment. [Office Action at page 2.]

The Secret Committee's incorrect statement that Applicant's new extensive experimental evidence is "cumulative to that already of record" is a clear example of its complete unfamiliarity with the record evidence and its failure to seriously consider it. Had it done so, the Committee most certainly would have addressed the glaring defects contained in sections 19-25 of the Attachment cited above, as pointed out in Applicant's previous Responses. The Committee's complete silence in the face of Applicant's compelling arguments is telling.

Furthermore, if the Committee were truly familiar with the record evidence of lower energy states of hydrogen, it would not have characterized Applicant's newly submitted evidence, which included unique scientific data, as "cumulative." To the contrary, that evidence included, for example, new analytical studies of isolated dihydrino gas (two lower-energy hydrogen atoms bonded together) and spectroscopic data showing the heretofore unseen sustained inverted hydrogen population generated by Applicant's lower-energy hydrogen process.

Members of and contributors to the Secret Committee apparently presume that they are better qualified to analyze the scientific data than the Ph.D. scientists who peer-reviewed and published that data per Committee requirements. Applicant, of course, has had no opportunity to rebut that presumption since the Committee refuses to divulge any information regarding its makeup. That refusal has further prevented Applicant from discovering the potential biases of persons who may have reviewed the record evidence and, perhaps, why they failed to fairly analyze it.

And so, the problems infecting the examination of this and other BlackLight cases, as identified and discussed above, have continued unabated through the most recent Office Action.

Summary of Discussions Held on February 11, 2003

Because of the lack of substance in the October 17 Office Action, Applicant sought once more to present his published scientific data evidencing lower-energy hydrogen at the Interview scheduled for February 11, 2003, and to discern the standards by which the ultimate decision-maker would be evaluating that data.

To that end, Applicant repeatedly requested that Examiner Jagannathan attend the Interview, since he had led the prior Interview held February 21, 2001, and, despite attempts to keep his identity secret, he is the only person known to have been directly involved in creating the substantive Office Actions of record. Specifically, Applicant sought to question Examiner Jagannathan why, after setting a standard that required Applicant to publish his scientific data, he still refuses to accept that data now published, or soon to be published, in over 50 peer-reviewed journal articles as evidence of lower-energy hydrogen. Applicant, however, never got the chance to pose that question. Without explanation, Examiner Jagannathan refused to attend the Interview, just as he had refused to attend the Interview held two years earlier, only this time, he did not show up.

Applicant also requested that Examiners Wayne Langel and Stephen Kalafut attend the Interview, since they had previously allowed the five BlackLight applications that were mysteriously withdrawn from issue and their names remain the only ones appearing in the record as signers of the substantive Office Actions under consideration. Examiners Langel and Kalafut appeared for the Interview, together with their immediate supervisors, SPE's Patrick Ryan and Stanley Silverman. Examiner William Wayner, who is assigned to one BlackLight application and expressed an interest in attending the Interview, also appeared.

Also attending the Interview and leading the discussions on the PTO's behalf was Quality Assurance Specialist Douglas McGinty, who until that time had never been identified to Applicant as having played any role in the examination of his applications.

Attending the Interview on behalf of BlackLight Power were the inventor, Dr. Randell L. Mills, his counsel, Jeffrey S. Melcher and Jeffrey A. Simenauer, and company Director Dr. Shelby Brewer.

Also attending the Interview as an observer at Applicant's request was Ted C. Liu, Senior Legislative Assistant for Congressman David Wu, who represents the 1st District of Oregon.

Prior to the Interview, Specialist McGinty asked that Mr. Liu speak by telephone with Talis Dzenitis, a Congressional Affairs Specialist in the PTO's Legislative and International Affairs Office, to discuss his reasons for attending. Mr. Liu explained to Specialist Dzenitis that a constituent associated with BlackLight had contacted Congressman David Wu complaining of the irregular procedures the PTO has used in examining the company's pending patent applications. The procedures complained of included the PTO's withdrawal of the five applications approved by Examiners Langel and Kalafut for issuance as patents and the subsequent rejection of those and other BlackLight applications by an unknown group of PTO officials referred to by Applicant as a "Secret Committee."

Specialist Dzenitis represented to Mr. Liu that no such secret committee exists at the Patent Office. Applicant was surprised by that representation considering that a group of anonymous PTO officials are known to be handling BlackLight's applications and drafting the substantive Office Actions that the Examiners of record are instructed to sign.

Examiner Langel confirmed as much in an extended discussion he had with Mr. Liu and Applicant's counsel following the formal phase of the Interview. During that discussion, Examiner Langel repeated his prior denials of having authored the substantive Office Actions of record, even though those Actions bear his signature. Examiner Langel also repeated his previously expressed view that Applicant is entitled to patents on his novel hydrogen technology and that he wanted to issue those patents. Examiner Langel explained, however, that other PTO officials unknown to him having higher authority were responsible for drafting the substantive Office Actions he signed and for deciding whether to issue Applicant his patents.

The only person Examiner Langel could identify for Mr. Liu as "having something to do with the Office Actions" was Examiner Jagannathan, whose name does not appear on any Office Action. As noted above, Examiner Jagannathan kept his identity a secret from Applicant

until counsel exposed his direct involvement in creating the Office Actions of record and forced him to attend the prior Interview that he led on February 21, 2001. When the recent February 11, 2003 Interview started, it was Specialist McGinty, another previously unidentified PTO official, who led the discussion.

Following the telephone conversation with Specialist Dzenitis, in which he denied the existence of a secret committee, Mr. Liu joined the Interview already in progress. Applicant began the Interview with a general discussion of his novel hydrogen technology and a presentation of the experimental evidence confirming its operation and utility. [R. L. Mills, Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source, Attachment 85] Specifically, Applicant explained to the PTO officials in attendance how independent laboratory studies, including those conducted by a leading Los Alamos researcher and by a NASA funded group, as well as other highly reliable scientific data, demonstrate the existence of lower energy states of hydrogen underlying his technology.

At no time during Applicant's presentation did the PTO officials analyze or otherwise address to any significant degree the merits of that data proving the existence of lower-energy hydrogen. Rather, these officials—with the exception of Examiner Langel—raised non-technical arguments, similar to those raised in the pending Office Actions, why lower-energy hydrogen could not exist and, thus, why they were justified in according the real-world data little or no weight.

The first such argument, raised by Examiner Wayner, was based on unrelated technologies that have been subjected to ridicule in the scientific community, such as perpetual motion, cold fusion, and 100-miles-per-gallon carburetors. Examiner Wayner compared those controversial technologies to BlackLight's novel hydrogen chemistry and then asked Applicant: "How is your invention any different?"

Applicant pointed out significant differences. Unlike the wild inventions mentioned by Examiner Wayner, Applicant explained that BlackLight has actually reduced its inventions to practice, as demonstrated by the many working prototype energy cells developed over the past 10 years and the novel chemical compounds produced by the process, which were made available to the PTO in the past and again during the Interview. In fact, Applicant invited the

PTO officials to visit his laboratory in Cranbury, New Jersey and witness the operation of his energy cell for themselves, but like prior invitations, this one too was ignored.

Applicant further distinguished his claimed inventions based on the substantial body of experimental evidence that corroborates the existence of lower energy states of hydrogen. Again, none of the PTO officials who raised non-technical arguments questioning the operability of Applicant's novel hydrogen technology made any real attempt to analyze that corroborating evidence. Indeed, Examiner Wayner frankly admitted that his background was in Mechanical Engineering and, therefore, he was not qualified to conduct such an analysis.

Applicant acknowledges and appreciates Examiner Wayner's candor in this regard and as expressed throughout the Interview, which greatly assisted Applicant in flushing out the key problems discussed above that have plagued this and other BlackLight's applications since the Secret Committee took over examination of these cases.

Examiner Wayner also questioned why, if BlackLight's technology was such an important discovery, the company had not yet developed a commercial device for producing energy. Applicant explained the high cost of developing commercial products and, because BlackLight was not in that end of the business, it was looking to license patents on its technology to companies who were, once those patents are issued.

Concerned that Examiner Wayner might be introducing yet another new patentability standard—the requirement of a commercial product—before agreeing to issue a patent, counsel pressed the Examiner on whether that was his intention. Examiner Wayner plainly stated it was not and, in response to a specific question from Mr. Liu, affirmed that Applicant need not prove commercial applicability to secure a patent for his invention.

Applicant also became alarmed when Examiner Wayner referred generally to BlackLight's "detractors," but then specifically invoked only the name of Dr. Robert Park as someone who disputes the existence of lower energy states of hydrogen. As noted above, Dr. Park is the spokesman/lobbyist for Applicant's chief competitor, the APS, who was identified as having a "Deep Throat" contact in the Patent Office.

Applicant has raised the subject of Dr. Park's "Deep Throat" contact in prior Responses, as well as his hostile agenda aimed at sabotaging BlackLight's patent rights. In those Responses, Applicant reported Dr. Park's reputation for conducting "hatchet jobs" on new

technologies that threaten federal funding for the physicists he represents through the APS. To support his claim, Applicant cited to the Secret Committee a *Washington Post* article that rebuked Dr. Park for engaging in what it described as a “search-and-destroy mission” against inventors and scientists who seek to advance the bounds of science. [See Article dated June 25, 2000 (Attachment 68 submitted with March 1, 2001 Response)]

That article mentions how “Park’s anger permeates his rebuttals, which border on character assassination.” Noting that “thoroughness is not Park’s strong suit,” the article further suggests that his intentions may be less than honorable:

Park’s failure to gather first-hand data is unfortunate, but his selective omissions are far more serious. In at least one case, he violated basic principles of journalism and science itself by apparently suppressing information that conflicts with his foregone conclusion. . . . Such tactics are reminiscent of the behavior of a zealous DA who is so convinced that a suspect is guilty that he feels entitled to withhold some information from the jury.

The *Post* article further accurately describes Dr. Park as “a Washington lobbyist and PR flack for the American Physical Society,” and warns of the serious consequences of rushing to judgment without first-hand review of experimental evidence:

This is a serious matter, since even poorly documented vitriol can jeopardize a scientist’s reputation and future funding if it is disseminated with the complicity of a respected organization such as the American Physical Society.

Applicant’s counsel wanted to raise these issues again during the Interview and started to point out Dr. Park’s obvious motives for criticizing BlackLight’s competing technology, namely, that the APS lobbies Congress for, and ultimately receives, hundreds of millions of dollars in government funding for its pet projects. Specialist McGinty, however, cut counsel off, refusing to discuss the matter. When Specialist McGinty suggested that BlackLight has a “similar agenda,” noting its recent NASA contract, Applicant corrected him, explaining that BlackLight does not receive any government funding for its research. Specialist McGinty had no response and the discussion moved onto other, less controversial subjects.

Examiner Wayner raised other issues regarding the reliability of the scientific evidence presented by Applicant. That evidence included spectroscopic data, which counsel described as being equivalent to a “chemical fingerprint.” Counsel further noted that Dr. Park himself,

whom Examiner Wayner identified as BlackLight's chief antagonist, has proclaimed the extraordinary reliability of spectroscopic data.

Indeed, as documented in prior Responses, Dr. Park had this to say about the reliability of spectral data in another *Washington Post* article that the PTO cited in rejecting claims to BlackLight's technology:

The energy states of atoms are studied through their atomic spectra—light emitted at very specific wavelengths when electrons make a jump from one energy level to another. The exact prediction of the hydrogen spectrum was one of the first great triumphs of quantum theory; it is the platform on which our entire understanding of atomic physics is built. The theory accounts perfectly for every spectral line.

There is no line corresponding to a "hydrino" state. Indeed there is no credible evidence at all to support Mills' claim. [See 1/12/00 article *The Washington Post* at Attachment 67 filed with March 1, 2001 Response]

Yet when Applicant tried to present this highly reliable spectroscopic data at the Interview showing the spectral lines corresponding to lower-energy hydrogen, *i.e.*, a "hydrino" state, Examiner Wayner interrupted, stating that "spectroscopic lines are meaningless" and "don't mean a hill of beans" to him.

Counsel again became concerned that BlackLight's applications were being evaluated using rather loose patentability standards. Counsel therefore requested that the PTO officials provide some guidance regarding the evidentiary requirements they were imposing on Applicant. Specialist McGinty and Examiner Wayner at first did not respond directly to Counsel's request for guidance, but rather began questioning the accuracy of the test data Applicant submitted to confirm the existence of lower energy hydrogen.

Applicant explained that the submitted test data was generated by highly qualified Ph.D. scientists, many of whom represent independent laboratories. Applicant further noted how this data had been extensively peer-reviewed in the 50-plus articles published, or soon to be published, in prestigious scientific journals, including the *Journal of Applied Physics* and *Journal of Molecular Structure*.

Applicant was astounded by the refusal of Specialist McGinty and Examiner Wayner to accept the reliability of the scientific data appearing in these published journal articles, especially considering the PTO's routine acceptance of evidence submitted in printed

publications to overcome utility rejections. See, e.g., MPEP § 2107.01 (VI) pp. 2100-33 ("An applicant can [submit evidence in response to a utility rejection] using any combination of the following: amendments to the claims, arguments or reasoning, or new evidence submitted in an affidavit or declaration under 37 CFR 1.132, or in a **printed publication.**") (emphasis added).

Counsel further reminded the PTO officials of the standard imposed by lead-Examiner Jagannathan during the previous Interview held February 21, 2001 that conditioned his consideration of evidence of lower-energy hydrogen on its publication in peer-reviewed journal articles based on the reliability of the peer-review process.

Counsel then noted once again that, despite Examiner Jagannathan's failure to provide legal authority for imposing this inflated standard, Applicant had not only met, but had exceeded it with over 50 journal articles. Having done so, counsel expressed extreme frustration with the PTO's continued refusal to seriously analyze the published scientific data based on manufactured excuses, such as this most recent one concerning the accuracy of the data.

Specialist McGinty raised a similar excuse for ignoring the published data by asking what assurances Applicant could provide that the journal articles had been actually peer reviewed! Mystified by that question, Applicant could only state what is a simple known fact—to get scientific data published in a journal article, it must first go through a rigorous peer-review process. Indeed, many of Applicant's articles went through numerous drafts and required further experimentation as directed by the Ph.D. scientists who peer reviewed those articles.

At that point in the Interview, Specialist McGinty admitted that, like Examiner Wayner, he was not qualified to analyze the published data. Applicant was surprised by that admission, since the Interview was being led by Specialist McGinty and had been arranged for the express purpose of presenting the experimental evidence of record.

Examiner McGinty's admission merely fueled Applicant's prior concerns that the published scientific data was not being properly considered, prompting counsel to ask who was responsible for analyzing that data. Specialist McGinty replied by stating that Examiners Langel and Kalafut, the Examiners of record, had that responsibility. That too came as a surprise, since Examiners Langel and Kalafut, of course, were the ones who had originally reviewed Applicant's experimental evidence in allowing the five BlackLight applications that were subsequently withdrawn from issue. Applicant, however, was relieved to learn that the two

Examiners, with over 50 years of experience between them and obviously qualified to analyze the published data, were being reassigned that task.

Counsel then addressed the vexing problem of changing standards for patentability imposed throughout the examination process. Counsel specifically mentioned, for example, the prior Office Action claiming Applicant's lower-energy hydrogen technology violated known laws of physics and chemistry without specifically identifying even one such law, and then requiring Applicant to prove otherwise.

Counsel also cited a recent Office Action dismissing Applicant's scientific data out of hand for failing to prove the invalidity of quantum theory:

The request for reconsideration has been entered and considered but does not overcome the rejection . . . because there is no evidence presented which would prove applicant's contention that the theory of quantum mechanics is invalid." [October 7, 2002 Office Action entered in U.S. Serial No. 09/110,717]

When Specialist McGinty accused Applicant of putting a "spin" on the Examiner's rejection, counsel noted that he had been reading the above quotation directly from the Office Action.

Counsel also mentioned the most recent Office Action filed in this and other cases dismissing Applicant's recent submission of peer-reviewed journal articles, in accordance with the standards imposed by Examiner Jagannathan, as being merely "cumulative" when it clearly was not and even the originally submitted evidence had not been properly analyzed.

Expressing frustration over the PTO's lack of any consistent patentability standard to guide Applicant, counsel once again requested that Specialist McGinty provide such guidance. Specialist McGinty again raised concern over the integrity of the experimental evidence, but indicated that he would be more receptive to that evidence if it was validated by independent third parties.

Applicant explained to Specialist McGinty that much of the evidence submitted over the previous four years was, in fact, generated by independent third parties. Applicant then began citing examples of the extensive independent third-party evidence disclosed in publications previously cited to the PTO, as well as some recently generated evidence, which has been

submitted herewith.¹ Specialist McGinty did not respond, whereupon counsel noted that his unfounded concern that the record evidence lacked third-party validation merely demonstrated the PTO's failure to thoroughly analyze that evidence.

Further demonstrating a lack of familiarity with the record evidence, Specialist McGinty criticized Applicant's experimental evidence as a whole by referring numerous times to only high-power plasma data. Applicant repeatedly pointed out that the plasma data was but a small fraction of the submitted evidence and that it was presented primarily to provide additional support for his plasma-related applications.

Applicant noted that the vast body of other scientific data he submitted relates to a broad range of analytical studies demonstrating the existence of lower energy states of hydrogen. For example, regarding those applications relating to novel chemical compounds, Applicant pointed Specialist McGinty to the extensive spectroscopic data supporting the identification of those compounds. Specialist McGinty, however, apparently did not understand the significance of that data, stating that the NMR data confirming lower-energy hydrogen could have been due to nitrogen. Applicant had to explain that, as a matter of basic scientific knowledge, NMR data only shows protons and that no other element but hydrogen is in the data range.

Knowing that highly qualified Examiners Langel and Kalafut were once again responsible for analyzing the published data was reassuring. There still remained, however, one nagging issue, namely, who had the ultimate authority to make that decision. Counsel expressed concern that the pending applications were being examined in secret and that, without knowing who had the authority to issue the patents, Applicant was being unfairly denied an opportunity to present his case to the actual decision-maker.

¹ See: R. L. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", Int. J. Hydrogen Energy, Vol. 26, No. 9, (2001), pp. 965-979.

R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.

J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", Journal of Applied Physics, submitted.

A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.

Specialist McGinty then stated in no uncertain terms that Examiners Langel, Kalafut, and Wayner, the signers of the Office Actions under consideration, had “full authority” to examine the pending applications and to issue Applicant his patents.

Upon hearing that statement, counsel immediately turned to Examiner Langel and asked him point blank whether, after having studied the experimental evidence of record, he still believes that BlackLight’s patent applications were allowable. The Examiner replied in no uncertain terms, “Yes, they’re still allowable.”

Counsel then asked Examiner Langel whether he was prepared to immediately allow the claims and issue Applicant his patents in those applications assigned to him, as is customary during an Interview, to which the Examiner replied, “Fine with me.”

Specialist McGinty, however, expressed uneasiness over Examiner Langel’s agreement to allow claims at the Interview. Specifically, he stated his concern that even if Applicant’s claimed technology were found to be operable, there were still issues of novelty and nonobviousness to be addressed before a patent could be issued.

Counsel was surprised by that statement given the Secret Committee’s arguments over the past three years that Applicant’s inventions are inoperable based on an incorrect assumption that lower-energy hydrogen cannot possibly exist. Counsel pointed out the obvious contradiction in now arguing that the Examiners may still need to conduct a prior art search for possible disclosure of Applicant’s lower-energy hydrogen technology.

Counsel further noted the PTO’s own examination guidelines requiring Examiners to evaluate the operability and utility of a claimed invention together with its novelty and nonobviousness following a complete prior art search. See MPEP § 706 (“After the application has been read and the claimed invention understood, a prior art search for the claimed invention is made. With the results of the prior art search, including any references provided by the applicant, the patent application should be reviewed and analyzed in conjunction with the state of the prior art to determine whether the claims define a useful, novel, nonobvious, and enabled invention that has been clearly described in the specification. The goal of examination is to clearly articulate any rejection early in the prosecution process so that the applicant has the opportunity to provide evidence of patentability and otherwise reply completely at the earliest opportunity.”)

Counsel again turned to Examiner Langel to confirm whether that was his understanding. The Examiner replied that it was and indicated that, in fact, the first thing he did was to conduct a thorough prior art search because he thought that might be the easiest way to dispose of the applications assigned to him. Examiner Langel explained, however, that he was unable to reject the applications on prior art grounds, which was why he originally allowed them.

Counsel acknowledged Specialist McGinty's hesitation to issue Applicant patents covering his claims at the Interview and assured him that Applicant wanted to work with him to remove any lingering concerns. Counsel then specifically asked Specialist McGinty to articulate how they might proceed in trying to accomplish that mutually beneficial goal. In response, Specialist McGinty indicated that, in the next Response to the pending Office Actions, Applicant should focus on identifying the scientific data generated by independent third-party testing, as opposed to test data generated solely by Applicant. Counsel agreed to do that.

Specialist McGinty further expressed concern over whether that scientific data, even if assumed to be reliable, was commensurate with the scope of the claims of the various applications to adequately support patentability. Counsel stated that Applicant's data did adequately support the claimed subject matter. Counsel, however, recommended reviewing the claims of each application one by one with the assigned Examiners to see if at least some agreement could be reached as to those claims that are adequately supported and for which patents can be issued. As for any remaining claims that the Examiners believe are not adequately supported by the scientific data, Applicant would be free to seek such broader claim coverage through continued prosecution.

Specialist McGinty agreed that this was a reasonable way to proceed and granted a request by counsel, Mr. Simenauer, that this agreement be memorialized in writing in an attachment to the Interview Summary Form. Mr. Simenauer offered to draft this agreement, as is common practice, and Specialist McGinty enthusiastically accepted the offer. Mr. Simenauer then drafted the following Attachment as Specialist McGinty looked on:

ATTACHMENT TO INTERVIEW SUMMARY FORM

Applicant requested that the following points discussed at the Interview held on February 11, 2003 be included as an Attachment to the Interview Summary Form.

Applicant's counsel and the Examiners in attendance at the Interview agreed to meet again at a future date, either in person or by telephone, to continue discussions regarding the patentability of Applicant's pending patent applications. Specifically, the Examiners expressed concern that Applicant's experimental evidence be commensurate with the scope of the claims. To address that concern, Applicant's counsel agreed with the Examiners to go through the patent applications claim-by-claim with the Examiners and demonstrate how the scientific data supports those claims.

For those claims that are supported by the data, the PTO agrees to issue those claims. For those claims that the PTO determines are not supported by the data, Applicant will continue to seek that broader claim coverage in subsequent proceedings.

After completing the two-page handwritten Attachment, Mr. Simenauer read it out loud in the presence of Specialist McGinty and Examiner Langel so that they could confirm its accuracy and make any necessary changes. When asked by counsel whether they were satisfied with the wording of the Attachment, Specialist McGinty stated that he was, as did Examiner Langel, who then signed each of the two pages. There was absolutely no confusion as to the agreement to issue patents for those claims found to be supported by the scientific data.

Incredibly, in a transparent attempt to rewrite history, some unknown PTO official apparently instructed Examiner Langel to sign a subsequent communication mailed over two weeks later, on February 26, 2003, that included an attached "Supplement to Interview Summary," which provides in pertinent part:

The following is a supplement to the summary concerning the February 11, 2003 interview re 09/501,622, etc. . . . A two-page Interview Summary was provided by Examiner Langel. A two page "Attachment to Interview Summary Form" also was provided by Mr. Simenauer. While the Attachment may represent the applicant's understanding of the interview, two points must be clarified.

First the second page of the applicant's attachment states in part: "for those claims that are supported by the data, the PTO agrees to issue those claims." The PTO made no such agreement. Instead, the PTO representatives indicated that the rejections under both 35 USC 101 and 112, 1st para., are outstanding and that evidence as to verification by credible, established, independent third parties would carry more persuasive weight.

Second, QAS Douglas McGinty was not listed in the Examiner's Interview Summary. He was present during the interview with the aforementioned attendees.

[signed] Wayne Langel
Primary Examiner
Art unit 1754

If PTO officials want to retract one of the key agreements reached at the Interview, they should expressly say so, identifying who made the decision and giving reasons for the retraction. Otherwise, Applicant has no choice but to rely on the accuracy of the contemporaneous written record.

Moreover, in view of other agreements reached at the Interview, the suggestion that there was no agreement to issue patents under the stated conditions is absurd—though hardly surprising given the sordid prosecution history of BlackLight's patent applications. Specialist McGinty plainly stated on the record that the Examiners who signed the outstanding rejections have full authority to review the data and to issue Applicant his patents. Also of record is Examiner Langel's unequivocal statement that, based on his review, he is prepared to issue those patents. To then force this same Examiner to sign a statement two weeks after the fact denying that "for those claims that are supported by the data, the PTO agrees to issue those claims" is embarrassing.

In light of the controversial prosecution history of this and other pending cases, Applicant appreciated what seemed to be Specialist McGinty's willingness to set reasonable standards and guidelines by which Applicant's patents can finally be issued. Applicant acknowledged and documented above Specialist McGinty's concern over the reliability of the record evidence, including his requirement that Applicant identify independent third-party verification of the scientific data as noted in the Supplemental Interview Summary. With these standards and guidelines in mind, Applicant presents below a summary of the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties.

In view of Specialist McGinty's representation that Examiner Langel is responsible for reviewing the data and the Examiner's reaffirmation that, based on his prior review of that data, the claims in this and other assigned cases are allowable, no follow-up discussion regarding the scope of those claims is believed necessary. Therefore, in view of Specialist McGinty's further

representation that Examiner Langel has full authority to grant Applicant his patents, this case is clearly in condition for allowance and a Notice to that affect is earnestly solicited.

Experimental Evidence Generated by Independent Third Parties

Applicant is unaware of any statutes, rules, or case law requiring that experimental evidence submitted by an Applicant in response to a rejection by the PTO be generated by independent third parties. Despite the higher standard imposed by Specialist McGinty requiring such third-party validation of the evidence, Applicant still has met and far exceeded this standard as shown below.

Applicant provides an alphabetical listing of independent third-party laboratories and universities that conducted the experiments and generated the scientific data relied upon and discussed in the 45 analytical studies that follow this list:

Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base

Atomic Energy Canada Limited, Chalk River Laboratories

Brookhaven National Laboratory

Charles Evans & Associates, Sunnyvale, CA

Environmental Catalysis and Materials Laboratory of Virginia Polytechnic Institute

Franklin and Marshall College

Galbraith Laboratories, Inc., Knoxville, TN

Grace Davison, Columbia, MD

IC Laboratories, Amawalk, NY

Idaho National Engineering Laboratory

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany)

Jobin Yvon Inc., Edison, NJ

Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER)

Liebert Corporation, Division of Emerson Corporation

Los Alamos National Laboratory

Material Testing Laboratory, Pennington, NJ

MIT Lincoln Laboratories

Moscow Power Engineering Institute

NASA Lewis

National Research Council of Canada

PacifiCorp

Pennsylvania State University Chemical Engineering Department

Perkin-Elmer Biosystems, Framingham, MA

Ricerca, Inc., Painesville, Ohio

Rider University, Lawrenceville NJ

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel

Ruhr University, Bochum, Germany

Shrader Analytical & Consulting Laboratories

Spectral Data Services, Inc., Champaign, IL

S. S. W., University of Western Ontario, Canada

Surface Science Laboratories, Mountain View, CA

Thermacore, Inc., Lancaster, PA

University of Delaware, Wilmington, DE

University of Massachusetts Amherst, Amherst, MA

University of New Mexico

Westinghouse Electric Corporation

Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA

The following 45 abstracts briefly describe the analytical studies of the scientific data generated by these independent third parties (highlighted in underline).

Independent Test Results

45. Dr. K.D. Keefer, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization by Liebert Corporation, (2001), and, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization, (2002).

Two separate reports disclosing the results of NMR, TOF-SIMS, XPS identification of novel hydrino hydride compounds and analysis of chemically-produced plasma by an expert hired by the Liebert Corporation, a division of the well-known and highly-respected Emerson Corporation. According to the expert's own words, he "observed demonstrations of the BlackLight Power (BLP) process and . . . reached the inescapable conclusion that it is based on extraordinary chemical reactions that seem to release extraordinary amounts of energy. . . It is [his] professional opinion that the BLP process represents a chemical conversion of atomic hydrogen unlike any previously reported [in] the archival scientific literature." Although the expert states that he was skeptical of Applicant's theory, he admitted that the chemical and plasma data did support Applicant's fractional quantum states and that he could offer no other explanation of the data using conventional quantum theory.

44. **A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.**

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated. See

i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos,

ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths,

iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos,

iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species, and

v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.

43. J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", *Journal of Applied Physics*, submitted.

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. Water bath calorimetry was used to demonstrate one more peculiar phenomenon associated with a certain class of mixed gas plasmas termed resonant transfer, or rt-plasmas. Specifically, $He/H_2(10\%)$ (500 mTorr), $Ar/H_2(10\%)$ (500 mTorr), and $H_2O(g)$ (200 mTorr) plasmas generated with an Evenson microwave cavity consistently yielded on the order of 50% more heat than non rt-plasma (controls) such as He , Kr , $Kr/H_2(10\%)$, under identical conditions of gas flow, pressure, and microwave operating conditions. The excess power density of rt-plasmas was of the order $10\text{ W}\cdot\text{cm}^{-3}$. In earlier studies with these same rt-plasmas it was demonstrated that other unusual features were present including dramatic broadening of the hydrogen Balmer series lines, unique vacuum ultraviolet (VUV) lines, and in the case of water plasmas, population inversion of the hydrogen excited states. Both the current results and the earlier results are completely consistent with the existence of a hitherto unknown exothermic chemical reaction, such as that predicted by Mills, occurring in rt-plasmas.

42. R. L. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, B. Dhandapani, J. Phillips, "Spectroscopic Study of Unique Line Broadening and Inversion in Low Pressure Microwave Generated Water Plasmas", *Physics of Plasmas*, submitted.

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. It was demonstrated that low pressure (~ 0.2 Torr) water vapor plasmas generated in a 10 mm ID quartz tube with an Evenson microwave cavity show at least two features which are not explained by conventional plasma models. First, significant ($> 2.5\text{ \AA}$) hydrogen Balmer α line broadening was recorded, of constant width, up to 5 cm from the microwave coupler. Only hydrogen, and not oxygen, showed significant line broadening. This feature, observed previously in hydrogen-containing mixed gas plasmas generated with high voltage DC and RF discharges was explained by some researchers to result from acceleration of hydrogen ions near the cathode. This explanation cannot apply to the line broadening observed in the (electrodeless) microwave plasmas generated in this work, particularly at distances as great as 5 cm from the microwave coupler. Second, dramatic inversion of the line intensities of both the Lyman and Balmer series, again, at distances up to 5 cm from the coupler were observed. The dramatic line inversion suggests the existence of a hitherto unknown source of

pumping of the optical power in plasmas. Finally, it is notable that other aspects of the plasma including the OH^* rotational temperature and low electron concentrations are quite typical of plasmas of this type.

41. **H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, submitted.**

The generation of a hydrogen plasma with intense extreme ultraviolet and visible emission was observed at Ruhr University, Bochum, Germany from low pressure hydrogen gas (0.1-1 mbar) in contact with a hot tungsten filament only when the filament heated a titanium dissociator coated with K_2CO_3 above $750^\circ C$. The dissociator was electrically floated, and the electric field strength from the filament was about 1 V/cm, two orders of magnitude lower than the starting voltages measured for gas glow discharges. The emission of the H_α and H_β transitions as well as the L_α and L_β transitions were recorded and analyzed. The plasma seemed to be far from thermal equilibrium, and no conventional mechanism was found to explain the formation of a hydrogen plasma by incandescently heating hydrogen gas with the presence of trace amounts of K_2CO_3 . The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The plasma was found to be dependent on the chemistry of atomic hydrogen with potassium since no plasma formed with Na_2CO_3 replacing K_2CO_3 and the time constant of the emission following the removal of all of the power to the cell matched that of the cooling of the filament and the resulting shift from atomic to molecular hydrogen. Our results indicate that a novel chemical power source is present that forms the energetic hydrogen plasma. The plasma is a potential new light source.

40. **R. Mills, "Observation of Extreme Ultraviolet Emission from Hydrogen-KI Plasmas Produced by a Hollow Cathode Discharge", Int. J. Hydrogen Energy, Vol. 26, No. 6, (2001), pp. 579-592.**

A high voltage discharge of hydrogen with and without the presence of a source of potassium, potassium iodide, in the discharge was performed at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) with a hollow cathode. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g. $< 10^3 K$) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV [1, 3-5]. Two potassium ions or a potassium

atom may each provide an electron ionization or transfer reaction that has a net enthalpy equal to an integer multiple of 27.2 eV . The spectral lines of atomic hydrogen were intense enough to be recorded on photographic films only when KI was present. EUV lines not assignable to potassium, iodine, or hydrogen were observed at 73.0, 132.6, 513.6, 677.8, 885.9, and 1032.9 Å. The lines are assigned to transitions of atomic hydrogen to lower energy levels corresponding to lower energy hydrogen atoms called hydrino atoms and the emission from the excitation of the corresponding hydride ions formed from the hydrino atoms.

39. **R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a $Ti-K_2CO_3$ -H-Cell", *Int. J. Hydrogen Energy*, Vol. 26, No. 4, (2001), pp. 327-332.**

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) reports the generation of a hydrogen plasma and extreme ultraviolet emission as recorded via the hydrogen Balmer emission in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g. $> 10^6\text{ K}$) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g. $\approx 10^3\text{ K}$) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator coated with potassium carbonate. The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The persistence of emission following the removal of all of the power to the cell indicates that a novel chemical power source is present that forms an energetic plasma in hydrogen. No unusual behavior was observed with the control sodium carbonate.

38. **R. Mills, J. Sankar, P. Ray, J. He, A. Voigt, B. Dhandapani, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Argon-Hydrogen-Methane Plasma CVD Synthesis of Diamond Films", *J. of Materials Research*, submitted.**

Polycrystalline diamond films were synthesized on silicon substrates without diamond seeding by low power (80 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA),

Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH , C_2 , and C_3 emissions were observed. The argon-hydrogen plasma showed a significantly broadened H Balmer α line. The average hydrogen atom temperature of a argon-hydrogen plasma was measured to be 120-140 eV versus ≈ 3 eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

37. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", J. Phys. Chem. A, submitted.

$2K^+$ to $K + K^{2+}$ and K to K^{3+} provide a reaction with a net enthalpy equal to the one and three times the potential energy of atomic hydrogen, respectively. The presence of these gaseous ions or atoms with thermally dissociated hydrogen formed a so-called resonance transfer (rt) plasma having strong VUV emission with a stationary inverted Lyman population. Significant line broadening of the Balmer α , β , and γ lines of 18 eV was observed, compared to 3 eV from a hydrogen microwave plasma. Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero as recorded at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany). The reaction was exothermic since excess power of $20 \text{ mW} \cdot \text{cm}^{-3}$ was measured by Calvet calorimetry. An energetic catalytic reaction was proposed involving a resonant energy transfer between hydrogen atoms and $2K^+$ or K to form very stable novel hydride ions $H^-(1/p)$ called hydrino hydrides having a fractional principal quantum numbers $p = 2$ and $p = 4$, respectively. Characteristic emission was observed from K^{2+} and K^{3+} that confirmed the resonant nonradiative energy transfer of 27.2 eV and $3 \cdot 27.2$ eV from atomic hydrogen to $2K^+$ and K , respectively.

The predicted binding energy of $H^-(1/2)$ of 3.0471 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4 . $H^-(1/4)$ was observed spectroscopically at 110 nm corresponding to its predicted binding energy of

11.2 eV. The ^1H MAS NMR spectrum (Spectral Data Services, Inc., Champaign, IL) of novel compound KH^*Cl relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $p = 4$. A novel NMR (Grace Davison, Columbia, MD and Spectral Data Services, Inc., Champaign, IL) peak of KH^*I at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of $p = 2$. The predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for $\text{H}^-(1/2)$ and $\text{H}^-(1/4)$ were found to be in agreement.

36. **R. L. Mills, P. Ray, B. Dhandapani, J. He, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas", Polish Journal of Chemistry, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $\text{He}(1s^2)$ to $\text{He}(1s^1 2p^1)$. These lines matched $\text{H}(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+ . Corresponding emission due to the reaction $2\text{H}(1/2) \rightarrow \text{H}_2(1/2)$ with vibronic coupling at $E_{D+\text{vib}} = p^2 E_{D\text{H}_2} \pm \left(\frac{\nu^*}{3}\right) E_{\text{vib H}_2(\nu=0 \rightarrow \nu=1)}$, $\nu^* = 1, 2, 3 \dots$ was observed at the longer wavelengths for $\nu^* = 2$ to $\nu^* = 32$ and at the shorter wavelengths for $\nu^* = 1$ to $\nu^* = 16$ where $E_{D\text{H}_2}$ and $E_{\text{vib H}_2(\nu=0 \rightarrow \nu=1)}$ are the experimental bond and vibrational energies of H_2 , respectively. Fractional-principal-quantum-level molecular hydrogen $\text{H}_2(1/p)$ gas was isolated by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), optical emission spectroscopy (OES), and ^1H NMR (Rider University, Lawrenceville NJ) of the condensable gas dissolved in CDCl_3 . The condensable gas was highly pure hydrogen by GC and MS and had a higher ionization energy than H_2 . An upfield shifted NMR peak was observed at 3.25 ppm compared to that of H_2 at 4.63 ppm. A theoretical rocketry propellant reaction is given that may be transformational.

35. R. L. Mills, J. Sankar, A. Voigt, J. H , B. Dhandapani, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Helium-Hydrogen-Methane Plasma CVD Synthesis of Single Crystal Diamond Films", *Chemistry of Materials*, in press.

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA and Jobin Yvon Inc., Edison, NJ), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH , C_2 , and C_3 emissions were observed with significantly broadened $H \alpha$, β , γ , and δ lines. The average hydrogen atom temperature of a helium-hydrogen-methane plasma was measured to be 120-140 eV versus ≈ 3 eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

34. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Low Power MPCVD of Diamond Films on Silicon Substrates", *Journal of Vacuum Science & Technology A*, submitted.

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4 . The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be

180-210 eV versus ≈ 3 eV for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

33. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.

A novel inorganic hydride compound, lithium chloro hydride ($LiHCl$), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

32. R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", Solar Energy Materials & Solar Cells, in press.

A novel highly stable hydrogen terminated silicon coating was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form highly stable silicon hydrides. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. Since hydrogen is the only element with no primary element peaks, X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the H content of the SiH coatings as comprising novel silicon hydrides due to new peaks at 11, 43, and 55 eV in the absence of corresponding peaks of any candidate element at higher binding energies. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen

passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

31. **R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Synthesis of HDLC Films from Solid Carbon", Thin Solid Films, submitted.**

A novel diamond-like carbon film terminated with $CH(1/p)$ (H^+DLC) comprising high binding energy hydride ions was synthesized from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. H^+DLC was identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) and X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA). TOF-SIMS identified the coatings as hydride by the large H^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. The XPS identification of the H content of the CH coatings as hydride ion $H^-(1/10)$ corresponding to a peak at 49 eV has implications that the mechanism of the diamond-like carbon formation involves one or both of selective etching of graphitic carbon and the activation of surface carbon by the hydrogen catalysis product. Thus, a novel H intermediate formed by the plasma catalysis reaction may serve the role of H , oxygen species, CO , or halogen species used in past systems. Bombardment of the diamond surface by observed, highly energetic species formed by the catalysis reaction may also play a role.

30. **R. L. Mills, J. He, P. Ray, B. Dhandapani, X. Chen, "Synthesis and Characterization of a Highly Stable Amorphous Silicon Hydride as the Product of a Catalytic Helium-Hydrogen Plasma Reaction", Int. J. Hydrogen Energy, in press.**

A novel highly stable surface coating $SiH(1/p)$ which comprised high binding energy hydride ions was synthesized by a microwave plasma reaction of a mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the H content of the SiH coatings as hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The silicon hydride

surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

The plasma which formed $SiH(1/p)$ showed a number of extraordinary features. Novel emission lines with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$ were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen where p is an integer, formed by a resonant nonradiative energy transfer to He^+ acting as a catalyst. The average hydrogen atom temperature of the helium-hydrogen plasma was measured to be 180-210 eV versus $\approx 3 \text{ eV}$ for pure hydrogen. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For example, for an input of 8.1 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 30.0 W corresponding to 21.9 W of excess power in 3 cm^3 . The excess power density and energy balance were high, 7.3 W/cm^3 and $-2.9 \times 10^4 \text{ kJ/mole } H_2$, respectively. This catalytic plasma reaction may represent a new hydrogen energy source and a new field of hydrogen chemistry.

29. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", Int. J. Hydrogen Energy, submitted.

A novel inorganic hydride compound lithium chloro hydride, $LiHCl$, which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

28. R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydride from Aqueous Electrolysis and Plasma Electrolysis", Electrochimica Acta, Vol. 47, No. 24, (2002), pp. 3909-3926.

After 10^4 hours of continuous aqueous electrolysis with K_2CO_3 as the electrolyte, highly stable novel inorganic hydride compounds such as $KHKHCO_3$ and KH were isolated and identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) (Charles Evans East, East Windsor, NJ). The existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) and solid state magic-angle spinning 1H nuclear magnetic resonance spectroscopy (1H MAS NMR) (Spectral Data Services, Inc., Champaign, IL). A novel ion formed by plasma electrolysis of a K_2CO_3 , Rb_2CO_3 , or Cs_2CO_3 electrolyte was also observed by high resolution visible spectroscopy at 407.0 nm corresponding to its predicted binding energy of 3.05 eV.

27. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", *Int. J. Hydrogen Energy*, Vol. 26, No. 9, Sept. (2001), pp. 965-979.

Novel inorganic alkali and alkaline earth hydrides of the formula MH^* , MH_2^* , and MH^*X wherein M is the metal, X , is a halide, and H^* comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and MH , MH_2 , or MX corresponding to an alkali metal or alkaline earth metal compound, respectively. Novel hydride ions of the corresponding novel hydride compounds were characterized by an extraordinary upfield shifted peak observed by 1H nuclear magnetic resonance spectroscopy. The result were confirmed on five different instruments at five independent laboratories (Spectral Data Services, Inc., Champaign, IL, National Research Council of Canada, University of Massachusetts Amherst, Amherst, MA, University of Delaware, Wilmington, DE, and Grace Davison, Columbia, MD).

26. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", *Int. J. of Hydrogen Energy*, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.

A novel inorganic hydride compound KHI which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and potassium iodide. Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H and ^{39}K nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), Fourier transform infrared spectroscopy (Surface Science

Laboratories, Mountain View, CA), electrospray ionization time of flight mass spectroscopy (Perkin-Elmer Biosystems, Framingham, MA), liquid chromatography/mass spectroscopy (Ricerca, Inc., Painesville, Ohio), thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis (Galbraith Laboratories, Inc., Knoxville, TN). Hydride ions with increased binding energies may form many novel compounds with broad applications.

25. R. Mills, "Novel Inorganic Hydride", *Int. J. of Hydrogen Energy*, Vol. 25, (2000), pp. 669-683.

A novel inorganic hydride compound $KHKHCO_3$ which is stable in water and comprises a high binding energy hydride ion was isolated following the electrolysis of a K_2CO_3 electrolyte. Inorganic hydride clusters $K[KHKHCO_3]^+$ were identified by Time of Flight Secondary Ion Mass Spectroscopy (Charles Evans East, East Windsor, NJ). Moreover, the existence of a novel hydride ion has been determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

24. R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis and Characterization of Novel Hydride Compounds", *Int. J. of Hydrogen Energy*, Vol. 26, No. 4, (2001), pp. 339-367.

Novel inorganic alkali and alkaline earth hydrides of the formula MHX and $MHMX$ wherein M is the metal, X , is a singly negatively charged anion, and H comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and MX or MX_2 corresponding to an alkali metal or alkaline earth metal, respectively. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g. $\approx 10^3 K$) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV [1-5]. These atomized elements or certain gaseous ions comprised the catalyst to form MHX and $MHMX$. For example, atomic hydrogen was reacted with strontium vapor and $SrBr_2$ to form $SrHBr$. Novel hydride compounds such as $SrHBr$ were identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and thermal

decomposition with analysis by gas chromatography, and mass spectroscopy. Hydride ions with increased binding energies form novel compounds with potential broad applications such as a high voltage battery for consumer electronics and electric vehicles. In addition, these novel compositions of matter and associated technologies may have far-reaching applications in many industries including chemical, electronics, computer, military, energy, and aerospace in the form of products such as propellants, solid fuels, surface coatings, structural materials, and chemical processes.

23. R. Mills, "Highly Stable Novel Inorganic Hydrides", Journal of New Materials for Electrochemical Systems, in press.

Novel inorganic hydride compounds $KHKHCO_3$ and KH were isolated following the electrolysis of a K_2CO_3 electrolyte. The compounds which comprised high binding energy hydride ions were stable in water, and KH was stable at elevated temperature (600 °C). Inorganic hydride clusters $K[KHKHCO_3]^+$ were identified by positive Time of Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) of $KHKHCO_3$ (Charles Evans East, East Windsor, NJ). The negative ToF-SIMS was dominated by hydride ion. The positive and negative ToF-SIMS of KH showed essentially K^+ and H^- only, respectively. Moreover, the existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

22. R. Mills, "Novel Hydrogen Compounds from a Potassium Carbonate Electrolytic Cell", Fusion Technology, Vol. 37, No. 2, March, (2000), pp. 157-182.

Novel compounds containing hydrogen in new hydride and polymeric states which demonstrate novel hydrogen chemistry have been isolated following the electrolysis of a K_2CO_3 electrolyte with the production of excess energy. Inorganic hydride clusters $K[KHKHCO_3]^+$ and hydrogen polymer ions such as OH_{23}^+ and H_{16}^- were identified by time of flight secondary ion mass spectroscopy (Charles Evans East, East Windsor, NJ). The presence of compounds containing new states of hydrogen were confirmed by X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), X-ray diffraction, Fourier transform infrared spectroscopy (Surface Science Laboratories, Mountain View, CA), Raman spectroscopy (Environmental Catalysis and Materials Laboratory of Virginia

Polytechnic Institute), and ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL).

21. Mills, R., Good, W., "Fractional Quantum Energy Levels of Hydrogen", Fusion Technology, Vol. 28, No. 4, November, (1995), pp. 1697-1719.

Determination of excess heat release during the electrolysis of aqueous potassium carbonate by the very accurate and reliable method of heat measurement, flow calorimetry; describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by X-ray Photoelectron Spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA); describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by emissions of soft X-rays from dark matter; describes the experimental identification of hydrogen molecules in fractional quantum energy levels—dihydrino molecules by high resolution magnetic sector mass spectroscopy with ionization energy determination, and gives a summary.

In summary:

Excess power and heat were observed during the electrolysis of aqueous potassium carbonate. Flow calorimetry of pulsed current electrolysis of aqueous potassium carbonate at a nickel cathode was performed in a single-cell dewar. The average power out of 24.6 watts exceeded the average input power (voltage times current) of 4.73 watts by a factor greater than 5. The total input energy (integration of voltage times current) over the entire duration of the experiment was 5.72 MJ; whereas, the total output energy was 29.8 MJ. No excess heat was observed when the electrolyte was changed from potassium carbonate to sodium carbonate. The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers: $n = 1/2, 1/3, 1/4, \dots$. Transitions to these lower energy states are stimulated in the presence of pairs of potassium ions (K^+/K^+ electrocatalytic couple) which provide 27.2 eV energy sinks.

The identification of the $n = 1/2$ hydrogen atom, $\text{H}(n = 1/2)$ is reported. Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA). A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of $\text{H}(n = 1/2)$

is 54.4 eV. Thus, the theoretical and measured binding energies for $H(n = 1/2)$ are in excellent agreement.

Further experimental identification of hydrinos—down to $H(n = 1/8)$ —can be found in the alternative explanation by Mills et al. for the soft X-ray emissions of the dark interstellar medium observed by Labov and Bowyer [Labov, S., Bowyer, S., "Spectral observations of the extreme ultraviolet background", *The Astrophysical Journal*, 371, (1991), pp. 810-819] of the Extreme UV Center of the University of California, Berkeley. The agreement between the experimental spectrum and the energy values predicted for the proposed transitions is remarkable.

The reaction product of two $H(n=1/2)$ atoms, the dihydrino molecule, was identified by mass spectroscopy (Shrader Analytical & Consulting Laboratories). The mass spectrum of the cryofiltered gases evolved during the electrolysis of a light water K_2CO_3 electrolyte with a nickel cathode demonstrated that the dihydrino molecule, $H_2\left(n = \frac{1}{2}\right)$, has a higher ionization energy, about 63 eV, than normal molecular hydrogen, $H_2(n = 1)$, 15.46 eV. The high resolution (0.001 AMU) magnetic sector mass spectroscopic analysis of the postcombustion gases indicated the presence of two peaks of nominal mass two-- one peak at 70 eV and one peak at 25 eV. The same analysis of molecular hydrogen indicates only one peak at 25 eV and one peak at 70 eV. In the case of the postcombustion sample at 70 eV, one peak was assigned as the hydrogen molecular ion peak, $H_2^+(n = 1)$, and one peak was assigned as the dihydrino molecular peak, $H_2^+\left(n = \frac{1}{2}\right)$ which has a slightly larger magnetic moment.

20. Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", *Fusion Technology*, Vol. 25, 103 (1994).

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed by Thermacore, Inc., Lancaster, PA. The excess power out of 41 watts exceeded the total input power given by the product of the electrolysis voltage and current by a factor greater than 8. Elemental analysis of the electrolyte and metallurgical analysis of the cathode showed no evidence of chemical reactions. The pH, specific gravity, concentration of K_2CO_3 , and the elemental analysis of the electrolyte sample taken after 42 days of continuous operation were unchanged from that of the values obtained for the electrolyte sample taken before operation. Elemental analysis and scanning electron microscopy of metallurgical samples of the nickel cathode taken before operation and at day 56 of continuous operation were identical indicating that the nickel cathode had not changed chemically or physically. Scintillation counter and photographic film

measurements showed that no radiation above background was detected indicating that nuclear reactions did not occur.

The "ash" of the exothermic reaction is atoms having electrons of energy below the "ground state" which are predicted to form molecules. The predicted molecules were identified by lack of reactivity with oxygen, by separation from molecular deuterium by cryofiltration, and by mass spectroscopic analysis. The combustion of the gases evolved during the electrolysis of a light water K_2CO_3 electrolyte (K^+/K^+ electrocatalytic couple) with a nickel cathode was incomplete. The mass spectroscopic analysis (Dr. David Parees of Air Products & Chemicals, Inc.) of the $m/e = 2$ peak of the combusted gas demonstrated that the dihydrino molecule, $H_2(n = 1/2)$, has a higher ionization energy than H_2 .

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cells by HydroCatalysis Power Corporation. Excess power out exceeded input power by a factor greater than 16. No excess heat was observed when the electrolyte was changed from potassium carbonate to the control sodium carbonate. The faraday efficiency was measured volumetrically to be 100%.

19. V. Noninski, Fusion Technol., Vol. 21, 163 (1992).

Dr. Noninski of the Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER) successfully reproduced the results of Mills and Kneizys [R. Mills and S. Kneizys, Fusion Technol. Vol. 20, 65 (1991)] as a visiting professor at Franklin and Marshall College. A significant increase in temperature with every watt input, compared with the calibration experiment ($\approx 50^\circ C/W$ versus $\approx 30^\circ C/W$), was observed during the electrolysis of potassium carbonate. This effect was not observed when sodium carbonate was electrolyzed. No trivial explanation (in terms of chemical reactions, change in heat transfer properties, etc.) of this effect were found.

18. Niedra, J., Meyers, I., Fralick, G. C., and Baldwin, R., "Replication of the Apparent Excess Heat Effect in a Light Water-Potassium Carbonate-Nickel Electrolytic Cell, NASA Technical Memorandum 107167, February, (1996). pp. 1-20.; Niedra, J., Baldwin, R., Meyers, I., NASA Presentation of Light Water Electrolytic Tests, May 15, 1994.

NASA Lewis tested a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994)] with the exception that it was minus the central cathode. A cell identical to the test cell with heater power only (no

electrolysis) was the calibration control and the blank cell with the heater power equal to zero. The test cell was also calibrated "on the fly" by measuring the temperature relative to the blank cell at several values of heater input power of the test cell. "Replication of experiments claiming to demonstrate excess heat production in light water-Ni- K_2CO_3 electrolytic cells was found to produce an apparent excess heat of 11 W maximum, for 60 W electrical power into the cell. Power gains ranged from 1.06 to 1.68." The production of excess energy with a power gain of 1.68 would require 0% Faraday efficiency to account for the observed excess power.

17. Technology Insights, 6540 Lusk Boulevard, Suite C-102, San Diego, CA 92121, "HydroCatalysis Technical Assessment Prepared for PacifiCorp", August 2, 1996.

This report documents a technical assessment of a novel source of hydrogen energy advanced by HydroCatalysis Power Corporation now BlackLight Power, Inc. (BLP). The assessment was conducted as part of the due diligence performed for PacifiCorp. It was conducted by a literature search and review, site visits to BLP and collaborating organizations, and telephone interviews with others active in the general area. A description of concept is provided in Section 3. Section 4 presents an assessment of the concept background, supporting theory, laboratory prototypes, projected initial products, and economic and environmental aspects. Section 5 documents the results of telephone interviews and site visits. An overall summary and conclusions are presented in the following section.

16. P. M. Jansson, "HydroCatalysis: A New Energy Paradigm for the 21st Century", Thesis Submitted in partial fulfillment of the requirements of the Masters of Science in Engineering Degree in the Graduate Division of Rowan University, May 1997, Thesis Advisors: Dr. J. L. Schmalzel, Dr. T. R. Chandrupatla, and Dr. A. J. Marchese, External Advisors: Dr. J. Phillips, Pennsylvania State University, Dr. R. L. Mills, BlackLight Power, Inc., W. R. Good, BlackLight Power, Inc.

This thesis reviews the problems of worldwide energy supply, describes the current technologies that meet the energy needs of our industrial societies, summarizes the environmental impacts of those fuels and technologies and their increased use by a growing global and increasing technical economy. The work also describes and advances the technology being developed by BlackLight Power, Inc. (BLP) a scientific company located in Princeton, New Jersey. BLP's technology purports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of the hydrogen atom to a lower energy state. Laboratory tests obtained as original research of this thesis as well as the

review of the data of others substantiate the fact that replication of the experimental conditions which are favorable to initiating and sustaining the new energy release process will generate controllable, reproducible, sustainable and commercial meaningful heat. For example, Jansson has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. Approximately 10^{-3} moles of hydrogen was admitted to a 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. In the three separate trials with a platinum filament hydrogen dissociator which was varied in length of 10 cm, 20 cm, and 30 cm, a mean power of 0.581, 0.818, and 1.572 watts was observed, respectively. The closed experiments were run to completion. The energy observed was 622, 369, and 747 kJ, respectively. This is equivalent to the generation of $6.2 \times 10^8\text{ J/mole}$, $3.7 \times 10^8\text{ J/mole}$, and $7.5 \times 10^8\text{ J/mole}$ of hydrogen, respectively, as compared to $2.5 \times 10^5\text{ J/mole}$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be at least 1000 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model. Convincing evidence is presented to lead to the conclusion that BLP technology has tremendous potential to achieve commercialization and become an energy paradigm for the next century. The research was also conducted as part of the due diligence performed for Atlantic Energy now Conectiv.

15. **Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. In three separate trials, between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon admission of approximately 10^{-3} moles of hydrogen to the 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. This is equivalent to the generation of 10^7 J/mole of hydrogen, as compared to $2.5 \times 10^5\text{ J/mole}$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be 100 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model.

14. **Phillips, J., Shim, H., "Additional Calorimetric Examples of Anomalous Heat from Physical Mixtures of K/Carbon and Pd/Carbon", January 1, 1996, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of ionic hydrogen spillover catalytic material: 40% by weight potassium nitrate (KNO_3) on graphitic carbon powder with 5% by weight 1%-Pd-on-graphitic carbon (K^+/K^+ electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst. However, no excess power was observed with flowing helium over the catalyst mixture. Rates of heat production were reproducibly observed which were higher than that expected from the conversion of all the hydrogen entering the cell to water, and the total energy observed was over four times larger than that expected if all the catalytic material in the cell were converted to the lowest energy state by "known" chemical reactions. Thus, "anomalous" heat, heat of a magnitude and duration which could not be explained by conventional chemistry, was reproducibly observed.

13. **Bradford, M. C., Phillips, J., "A Calorimetric Investigation of the Reaction of Hydrogen with Sample PSU #1", September 11, 1994, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of nickel oxide powder containing strontium niobium oxide ($\text{Nb}^{3+}/\text{Sr}^{2+}$ electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst which increased with increasing flow rate. However, no excess power was observed with flowing helium over the catalyst/nickel oxide mixture or flowing hydrogen over nickel oxide alone. Approximately 10 cc of nickel oxide powder containing strontium niobium oxide immediately produced 0.55 W of steady state output power at 523 K. When the gas was switched from hydrogen to helium, the power immediately dropped. The switch back to hydrogen restored the excess power output which continued to increase until the hydrogen source cylinder emptied at about the 40,000 second time point. With no hydrogen flow the output power fell to zero.

The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers: $n = 1/2, 1/3, 1/4, \dots$. Transitions to these lower energy states are stimulated in the presence of pairs of niobium and strontium ions ($\text{Nb}^{3+}/\text{Sr}^{2+}$ electrocatalytic couple) which provide 27.2 eV energy sinks.

12. **Jacox, M. G., Watts, K. D., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993.**

Idaho National Engineering Laboratory (INEL) operated a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994)] except that it was minus the central cathode and that the cell was wrapped in a one-inch layer of urethane foam insulation about the cylindrical surface. The cell was operated in a pulsed power mode. A current of 10 amperes was passed through the cell for 0.2 seconds followed by 0.8 seconds of zero current for the current cycle. The cell voltage was about 2.4 volts, for an average input power of 4.8 W. The electrolysis power average was 1.84 W, and the stirrer power was measured to be 0.3 W. Thus, the total average net input power was 2.14 W. The cell was operated at various resistance heater settings, and the temperature difference between the cell and the ambient as well as the heater power were measured. The results of the excess power as a function of cell temperature with the cell operating in the pulsed power mode at 1 Hz with a cell voltage of 2.4 volts, a peak current of 10 amperes, and a duty cycle of 20 % showed that the excess power is temperature dependent for pulsed power operation, and the maximum excess power was 18 W for an input electrolysis joule heating power of 2.14 W. Thus, the ratio of excess power to input electrolysis joule heating power was 850 %. INEL scientists constructed an electrolytic cell comprising a nickel cathode, a platinized titanium anode, and a 0.57 M K_2CO_3 electrolyte. The cell design appears in Appendix 1. The cell was operated in the environmental chamber in the INEL Battery Test Laboratory at constant current, and the heat was removed by forced air convection in two cases. In the first case, the air was circulated by the environmental chamber circulatory system alone. In the second case, an additional forced air fan was directed onto the cell. The cell was equipped with a water condenser, and the water addition to the cell due to electrolysis losses was measured. The data of the forced convection heat loss calorimetry experiments during the electrolysis of a 0.57 M K_2CO_3 electrolyte with the INEL cell showed that 13 W of excess power was produced. This excess power could not be

attributed to recombination of the hydrogen and oxygen as indicated by the equivalence of the calculated and measured water balance.

11. Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994.

Westinghouse Electric Corporation reports that excess heat was observed during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) where the electrolysis of aqueous sodium carbonate served as the control. The data of the temperature of the cell minus the ambient temperature shows that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, the potassium experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month. The net faraday efficiency of gas evolution was experimentally measured to be unity by weighing the experiment to determine that the expected rate of water consumption was observed. The output power exceeded the total input power. The data was analyzed by HydroCatalysis Power Corporation [Mills, R., Analysis by HydroCatalysis Power Corporation of Westinghouse Report Entitled "Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC", February 25, 1994].

10. Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995.

During the electrolysis of aqueous potassium carbonate, researchers working at MIT Lincoln Laboratories observed long duration excess power of 1-5 watts with output/input ratios over 10 in some cases with respect to the cell input power reduced by the enthalpy of the generated gas. In these cases, the output was 1.5 to 4 times the integrated volt-ampere power input. Faraday efficiency was measured volumetrically by direct water displacement.

9. Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/K_2CO_3 Cell", Atomic Energy Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994.

Atomic Energy Canada Limited, Chalk River Laboratories, report that 128 % and 138% excess heat were observed in separate experiments by flow calorimetry during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) in a closed cell, and that 138% was observed in an open cell.

8. Shaubach, R. M., Gernert, N. J., "Anomalous Heat From Hydrogen in Contact with Potassium Carbonate", Thermacore Report, March 1994.

A high temperature/high pressure/high power density industrial prototype gas cell power generator which produced 50 watts of power at 300 °C having a nickel surface area of only 300 cm² was successfully developed. A sample of the nickel tubing of the aqueous potassium carbonate permeation cell was analyzed by XPS at the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present; whereas, the control nickel tube showed no feature. The binding energy (in vacuum) of H(n = 1/2) is 54.4 eV. Thus, the theoretical and measured binding energies for H(n = 1/2) are in excellent agreement. No excess energy or 54.6 eV feature were observed when sodium carbonate replaced potassium carbonate.

7. Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate , Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994).

In a report prepared for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Thermacore reports, "anomalous heat was observed from a reaction of atomic hydrogen in contact with potassium carbonate on a nickel surface. The nickel surface consisted of 500 feet of 0.0625 inch diameter tubing wrapped in a coil. The coil was inserted into a pressure vessel containing a light water solution of potassium carbonate. The tubing and solution were heated to a steady state temperature of 249 °C using an I²R heater. Hydrogen at 1100 psig was applied to the inside of the tubing. After the application of hydrogen, a 32 °C increase in temperature of the cell was measured which corresponds to 25 watts of heat. Heat production under these conditions is predicted by the theory of Mills where a new species of hydrogen is produced that has a lower energy state than normal hydrogen. ESCA analysis, done independently by Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, have found the predicted 55 eV signature of this new species of hydrogen."

6. **Wiesmann, H., Brookhaven National Laboratory, Department of Applied Science, Letter to Dr. Walter Polansky of the Department of Energy Regarding Excess Energy Verification at Brookhaven National Laboratory, October 16, 1991.**

Calorimetry of continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cell by Noninski at Brookhaven National Laboratory. Dr. Weismann observed the experiment and reported the results to Dr. Walter Polansky of the U. S. Department of Energy. Dr. Weismann reports, "The claim is as follows. The temperature rise in the dewar is greater in the case of electrolysis as compared to using a resistor, even though the power dissipated is equal in both cases. According to Dr. Mills' theory, this apparent "excess power" is due to the fact that the electron in a hydrogen atom can "decay" to stable subinterger quantum levels. Dr. Noninski demonstrated this thermal effect at BNL." The observed rise in temperature for a given input power was twice as high comparing electrolysis versus heater power.

5. **Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26, 1993.**

The Moscow Power Engineering Institute experiments showed 0.75 watts of heat output with only 0.3 watts of total power input (power = VI) during the electrolysis of an aqueous potassium carbonate electrolyte with a nickel foil cathode and a platinized titanium anode. Excess power over the total input on the order of 0.45 watts was produced reliably and continuously over a period of three months. Evaluation of the electrolyte after three months of operation showed no significant change in its density or molar concentration. The cell was disassembled and inspected after over one month of operation at 0.1 amperes. This inspection showed no visible signs of a reaction between the electrodes and the electrolyte. The cell was re-assembled and operated as before. Excess energy was produced for the three month duration of the experiment. Scintillation counter measurements showed no signs of radiation external to the cell.

4. **Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University Bethlehem, PA, November 1993.**

Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS by Miller and Simmons of the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate

cells. The binding energy (in vacuum) of $H(n = 1/2)$ is 54.4 eV. Thus, the theoretical and measured binding energies for $H(n = 1/2)$ are in excellent agreement. Lehigh University has conducted an extensive investigation of the cathodes from heat producing as well as those from control cells. Miller concludes that "I was unable to find any other elements on the surface that cause the feature. The persistent appearance of a spectral feature near the predicted binding energy for many of the electrodes used with a K electrolyte is an encouraging piece of evidence for the existence of the reduced energy state hydrogen".

3. Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993.

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL). Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

2. Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994.

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory,

EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

1. Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994.

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

Despite the Secret Committee's refusal to seriously analyze this independent experimental evidence, most of which has already been submitted as Attachments, Applicant submits for the PTO's consideration additional experimental evidence herewith that was submitted for publication. An explanation of that experimental evidence in abstract format is attached hereto.

Now that Applicant has fully complied with the newest standard imposed by Specialist McGinty requiring independent validation of the experimental evidence of record, Applicant expects that this evidence will be accepted as reliable and that his patents will be issued.

Response to Secret Committee's argument precluding Applicant's Invention since it corresponds to quantum states that are fractional rather than integer

The Examiner argues that only integer quantum numbers have been observed experimentally. This is not true. The quark family of particles are observed to have fractional quantized charge. Nuclear spin quantum numbers can be fractions. Fermions have the fractional spin quantum number $1/2$. Fractional quantum numbers are observed for the fractional quantum hall effect. Of course, fractional quantum numbers are also common for macroscopic systems, such as waveguides and resonator cavities.

In the case of the Schrödinger solutions of the wave equation, arbitrary constants are chosen to give the quantum numbers experimentally observed 40 years before the postulation of the Schrödinger equation having these arbitrary nonphysical solutions. Since they are not based on physics they are not unique, and other solutions, each corresponding to any arbitrary constant in the corresponding Laguerre differential equation including reciprocal integers are equally valid as discussed previously.² Furthermore, it has been show that the results are plagued with internal inconsistencies and failure at matching other experimental data such as spin, angular

² R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.

momentum, rotational energy, scattering, highly excited states, ionization, stability with respect to radiation, etc.³.

It is well known that the excited energy states of atomic hydrogen are empirically given by Rydberg equation (Eq. (1a) for $n > 1$ in Eq. (1b)).

$$E_n = -\frac{e^2}{n^2 8\pi\epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} = -\left(\frac{1}{n}\right)^2 13.598 \text{ eV} \quad (1a)$$

$$n = 1, 2, 3, \dots \quad (1b)$$

The $n = 1$ state is the "ground" state for "pure" photon transitions (i.e. the $n = 1$ state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state may be possible by a resonant nonradiative energy transfer, such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common⁴. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling⁵.

According to Applicant's invention, atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as He^+ , which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2 \text{ eV}$, wherein m is an integer. The theory derived from Maxwell's equations was given previously⁶. The reaction involves a nonradiative energy

³ R. Mills, "The Nature of Free Electrons in Superfluid Helium—a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", *Int. J. Hydrogen Energy*, Vol. 26, No. 10, (2001), pp. 1059-1096.

R. Mills, "The Hydrogen Atom Revisited", *Int. J. of Hydrogen Energy*, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.

R. L. Mills, *The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics*, *Am. J. Phys.*, submitted.

⁴ N. V. Sidgwick, *The Chemical Elements and Their Compounds*, Volume I, Oxford, Clarendon Press, (1950), p.17.

⁵ M. D. Lamb, *Luminescence Spectroscopy*, Academic Press, London, (1978), p. 68.

⁶ R. L. Mills, "Classical Quantum Mechanics", *Physics Essays*, submitted.

R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", *Int. J. Hydrogen Energy*, Vol. 27, No. 5, (2002), pp. 565-590.

transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer} \quad (1c)$$

replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. The $n = 1$ state of hydrogen and the $n = \frac{1}{\text{integer}}$ states of hydrogen are nonradiative, but a transition between two nonradiative states is possible via a nonradiative energy transfer, say $n = 1$ to $n = 1/2$. Thus, a catalyst provides a net positive enthalpy of reaction of $m \cdot 27.2 \text{ eV}$ (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (1a) and (1c).

Substitution of Eq. (1c) into Eq. (1a) gives

$$E_n = -\frac{e^2}{n^2 8\pi\epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} = -(p)^2 13.598 \text{ eV} \quad p \text{ is an integer} \quad (2)$$

Thus, it can clearly be appreciated that Applicant's solutions of the energy levels of the hydrogen atom based on Maxwell's equations do in fact correspond to integer quantum numbers⁷. These

R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2003 Edition, posted at www.blacklightpower.com.

R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", *Int. J. Hydrogen Energy*, Vol. 25, (2000), pp. 919-943.

R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", *Int. J. Hydrogen Energy*, Vol. 27, No. 3, pp. 301-322.

R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", *J. Mol. Struct.*, Vol. 643, No. 1-3, (2002), pp. 43-54.

⁷ R. L. Mills, "Classical Quantum Mechanics", *Physics Essays*, submitted.

R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", *Int. J. Hydrogen Energy*, Vol. 27, No. 5, (2002), pp. 565-590.

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R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", *Int. J. Hydrogen Energy*, Vol. 27, No. 3, pp. 301-322.

same solutions can also be obtained as eigenvalue solutions of the Schrödinger equation as discussed previously⁸.

Maxwell's equations are physical laws, whereas the probability wave mechanics of the Schrödinger and Dirac equation can not possibly represent reality as discussed previously⁹. Maxwell's equations have been remarkably successful over a period of time about 100 years longer than quantum mechanics and QED. Applicant has further shown that they apply to the atomic level as well¹⁰. This was the goal of the founders of quantum mechanics, including Dirac, as discussed previously¹¹.

Applicant's spectroscopic data, which is of the nature upon which scientific theories are built shows that quantum mechanic theory in its present form embodied in the Schrödinger and

R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.

⁸ R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.

⁹ R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.

R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.

R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Am. J. Phys., submitted.

F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701

¹⁰ R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.

R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.

R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2003 Edition, posted at www.blacklightpower.com.

R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, Vol. 25, (2000), pp. 919-943.

R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322.

R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.

¹¹ R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Am. J. Phys., submitted.

Dirac equations is incomplete and incorrect. For example, extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$, where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $\text{He}(1s^2)$ to $\text{He}(1s^1 2p^1)$.¹² These states matched the predictions from Maxwell's equations given by Eqs. (1a, 1c) and are missed by the Schrödinger and Dirac equations. Thus, these theories need to be revised or discarded based on experimental data. Data takes precedence over theories—not the other way around as incorrectly asserted by the Secret Committee. The Committee in fact does not challenge the Applicant's assignment of the real world spectral lines to states given by Eqs. (1a, 1c) that correspond to states below the $n=1$ state. Nor does the Secret Committee offer any other explanation of the overwhelming amount of data presented by the Applicant. Studies given previously¹³ that experimentally confirm a novel reaction of atomic hydrogen that produces hydrogen in fractional quantum states at lower energies than the traditional "ground" ($n = 1$) state, a chemically generated or assisted plasma (rt-plasma), and novel hydride compounds include extreme ultraviolet (EUV) spectroscopy, characteristic emission from catalysis and the hydride ion products, lower-energy hydrogen emission, plasma formation, Balmer α line broadening, population inversion of hydrogen lines, elevated electron temperature, anomalous plasma afterglow duration, power generation, excessive light emission, and analysis of chemical compounds.

Response to Secret Committee's argument regarding quantum mechanics being the most successful theory in history

This is simply not true. If adherence to first principles laws are considered, it has never solved a single problem correctly. In addition such statements are incredulous as shown in

¹² R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Am. J. Phys., submitted.

¹³ Lower-Energy Hydrogen Experimental Data, summary of experimental data and corresponding journal article references submitted to the USPTO.

Applicant's paper [R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Am. J. Phys., submitted] and Appendix II of the Applicant's book, which follows [R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; September 2002 version posted at www.blacklightpower.com] (bold added for emphasis):

APPENDIX II

QUANTUM ELECTRODYNAMICS (QED) IS PURELY MATHEMATICAL AND HAS NO BASIS IN REALITY

The spin of the electron and the Lamb shift are calculated from first principles in closed form by Mills as shown in the Electron g Factor section and the Resonant Line Shape and Lamb Shift section, respectively. The spin angular momentum results from the motion of negatively charged mass moving systematically, and the equation for angular momentum, $\mathbf{r} \times \mathbf{p}$, can be applied directly to the wave function (a current density function) that describes the electron. The Lamb shift results from conservation of linear momentum of the photon. The Casimir effect is predicted by Maxwell's equations. These results demonstrate that QED has no basis in reality.

Quantum mechanics failed to predict the results of the Stern-Gerlach experiment which indicated the need for an additional quantum number. Quantum electrodynamics was proposed by Dirac in 1926 to provide a generalization of quantum mechanics for high energies in conformity with the theory of special relativity and to provide a consistent treatment of the interaction of matter with radiation. It relies on the unfounded notions of negative energy states of the vacuum, virtual particles, and gamma factors. From Weisskopf¹⁴, "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; 1.) does not explain nonradiation of bound electrons; 2.) contains an internal inconsistency with

¹⁴ V. F. Weisskopf, Reviews of Modern Physics, Vol. 21, No. 2, (1949), pp. 305-315.

special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; 3.) it admits solutions of negative rest mass and negative kinetic energy; 4.) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; 5.) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise. In 1947, contrary to Dirac's predictions, Lamb discovered a 1000 *MHz* shift between the $^2S_{1/2}$ state and the $^2P_{1/2}$ state of the hydrogen atom¹⁵. This so called Lamb Shift marked the beginning of modern quantum electrodynamics. In the words of Dirac¹⁶, "No progress was made for 20 years. Then a development came initiated by Lamb's discovery and explanation of the Lamb Shift, which fundamentally changed the character of theoretical physics. It involved setting up rules for discarding ...infinities..." Renormalization is presently believed to be required of any fundamental theory of physics¹⁷. However, dissatisfaction with renormalization has been expressed at various times by many physicists including Dirac¹⁸ who felt that, "This is just not sensible mathematics. Sensible mathematics involves neglecting a quantity when it turns out to be small—not neglecting it just because it is infinitely great and you do not want it!"

Throughout the history of quantum theory; wherever there was an advance to a new application, it was necessary to repeat a trial-and-error experimentation to find which method of calculation gave the right answers. Often the textbooks present only the successful procedure as if it followed from first principles and do not mention the actual method by which it was found. In electromagnetic theory based on Maxwell's equations, one deduces the computational algorithm from the general principles. In quantum theory, the logic is just the opposite. One chooses the principle to fit the empirically successful algorithm. For example, we know that it required a great deal of art and tact over decades of effort to get correct predictions out of QED. The QED

¹⁵ W. E. Lamb, R. C. Retherford, "Fine Structure of the Hydrogen Atom by a Microwave Method", R. C., Phys. Rev., Vol. 72, No. 3, August 1, (1947), pp. 241-243.

¹⁶ P. A. M. Dirac, From a Life of Physics, ed. A. Salam, et al., World Scientific, Singapore, (1989).

¹⁷ P. W. Milonni, The Quantum Vacuum, Academic Press, Inc., Boston, p. 90.

¹⁸ P. A. M. Dirac, Directions in Physics, ed. H. Hora and J. R. Shepanski, Wiley, New York, (1978), p. 36.

method of the determination of $(g - 2)/2$ from the *postulated* Dirac equation is based on a *postulated* powers series of α / π where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term which is processed over decades using ad hoc rules to remove infinities from each term that arises from *postulated* scores of *postulated* Feynman diagrams. Mohr and Taylor reference some of the Herculean efforts to arrive at g using QED¹⁹:

“the sixth-order coefficient $A_1^{(6)}$ arises from 72 diagrams and is also known analytically after nearly 30 years of effort by many researchers [see Roskies, Remiddi, and Levine (1990) for a review of the early work]. It was not until 1996 that the last remaining distinct diagrams were calculated analytically, thereby completing the theoretical expression for $A_1^{(6)}$ ”.

For the right experimental numbers to emerge, one must do the calculation (i.e. subtract off the infinities) in one particular way and not in some other way that appears in principle equally valid. For example, Milonni²⁰ presents a QED derivation of the magnetic moment of the electron which gives a result of the wrong sign and requires the introduction of an

“upper limit K in the integration over $k = \omega / c$ in order to avoid a divergence.”

A differential mass is arbitrarily added, then

“the choice $K = 0.42 mc / \hbar$ yields $(g - 2)/2 = \alpha / 2\pi$ which is the relativistic QED result to first order in α . [...] However, the reader is warned not to take these calculations too seriously, for the result $(g - 2)/2 = \alpha / 2\pi$ could be obtained by

¹⁹ P. J. Mohr and B. N. Taylor, “CODATA recommended values of the fundamental physical constants: 1998”, Reviews of Modern Physics, Vol. 72, No. 2, April, (2000), p. 474.

²⁰ P. W. Milonni, The Quantum Vacuum An Introduction to Quantum Electrodynamics, Academic Press, Inc. Boston, pp. 107-111.

retaining only the first (radiation reaction) term in (3.112) and choosing $K = 3mc/8\hbar$. It should also be noted that the solution $K \cong 0.42mc/\hbar$ of (3.112) with $(g - 2)/2 = \alpha/2\pi$ is not unique.”

Such an ad hoc nonphysical approach makes incredulous:

“ the cliché that QED is the best theory we have!”²¹

or the statement that:

“The history of quantum electrodynamics (QED) has been one of unblemished triumph”.²²

There is a corollary, noted by Kallen: from an inconsistent theory, any result may be derived.

The QED determination of the postulated power series in α/π is based on scores of Feynman diagrams corresponding to thousands of matrices with thousands of integrations per matrix requiring decades to reach a consensus on the “appropriate” algorithm to remove the intrinsic infinities. Remarkably, $(g - 2)/2$ may be derived in closed form from Maxwell’s equations in a simple straightforward manner that yields a result with eleven figure agreement with experiment—the limit of experimental capability. Rather than an infinity of radically different QED models, an essential feature is that *Maxwellian solutions are unique*. The derivation from first principles without invoking virtual particles, zero point fluctuations of the vacuum, and negative energy states of the vacuum is given in the Electron g Factor section.

Furthermore, Oskar Klein pointed out a glaring paradox implied by the Dirac equation which was never resolved²³. “Electrons may penetrate an electrostatic barrier even when their

²¹ P. W. Milonni, The Quantum Vacuum An Introduction to Quantum Electrodynamics, Academic Press, Inc. Boston, p. 108.

²² G. P. Lepage, “Theoretical advances in quantum electrodynamics, International Conference on Atomic Physics, Atomic Physics; Proceedings, Singapore, World Scientific, Vol. 7, (1981), pp. 297-311.

kinetic energy, $E - mc^2$ is lower than the barrier. Since in Klein's example the barrier was infinitely broad this could not be associated with wave mechanical tunnel effect. It is truly a paradox: Electrons too slow to surpass the potential, may still only be partially reflected. ...Even for an infinitely high barrier, i.e. $r_2 = 1$ and energies $\approx 1 \text{ MeV}$, (the reflection coefficient) R is less than 75%! From (2) and (3) it appears that as soon as the barrier is sufficiently high: $V > 2mc^2$, electrons may transgress the repulsive wall-seemingly defying conservation of energy. ...Nor is it possible by way of the positive energy spectrum of the free electron to achieve complete Einstein causality."

The Rutherford experiment demonstrated that even atoms are comprised of essentially empty space²⁴. Zero-point field fluctuations, virtual particles, and states of negative energy and mass invoked to describe the vacuum are nonsensical and have no basis in reality since they have never been observed experimentally and would correspond to an essentially infinite cosmological constant throughout the entire universe including regions of no mass. As given by Waldrop²⁵, "What makes this problem into something more than metaphysics is that the cosmological constant is observationally zero to a very high degree of accuracy. And yet, ordinary quantum field theory predicts that it ought to be enormous, about 120 orders of magnitude larger than the best observational limit. Moreover, this prediction is almost inescapable because it is a straightforward application of the uncertainty principle, which in this case states that every quantum field contains a certain, irreducible amount of energy even in empty space. Electrons, photons, quarks—the quantum field of every particle contributes. And that energy is exactly equivalent to the kind of pressure described by the cosmological constant. The cosmological constant has accordingly been an embarrassment and a frustration to every physicist who has ever grappled with it."

²³ H. Wergeland, "The Klein Paradox Revisited", Old and New Questions in Physics, Cosmology, Philosophy, and Theoretical Biology, A. van der Merwe, Editor, Plenum Press, New York, (1983), pp. 503-515.

²⁴ Beiser, A., Concepts of Modern Physics, Fourth Edition, McGraw-Hill Book Company, New York, (1978), pp. 119-122.

²⁵ M. M. Waldrop, *Science*, Vol. 242, December, 2, (1988), pp. 1248-1250

Furthermore, a consequence of the Heisenberg Uncertainty principle and QED is that matter may be created from nothing, including vacuum. Taking quantum theory into account, Stephen Hawking²⁶ mathematically proved that blackholes must emit Hawking radiation comprising photons, neutrinos, and all sorts of massive particles. "The surface emits with equal probability all configurations of particles compatible with the observers limited knowledge. It is shown that the ignorance principle holds for quantum-mechanical evaporation of blackholes: The black hole creates particles in pairs, with one particle always falling into the hole and the other possibly escaping to infinity."²⁷ This QM theorem represents a perpetual motion machine with regard to spontaneous creation of mass and energy from the vacuum and with regard to gravitation. (QM also predicts a perpetual motion machine of the second kind²⁸). Contrary to prediction, Hawking radiation has never been observed²⁹. Classical laws including conservation of matter-energy are confirmed and QM is invalidated.

The Casimir effect is often touted as proof of that the vacuum is teeming with infinities of virtual particles. The experiment comprises a feeble force between two plates with precision machined surfaces that are brought within microns of contacting each other. The QED explanation of the weak force that is observed between the two plates is that the plates serve to limit the number of virtual particle modes between the plates as opposed to those outside the plates and the resulting imbalance in pressure between two infinite quantities gives rise to the feeble force.³⁰

²⁶ S. W. Hawking, "Particle creation by black holes", Commun. Math Phys., Vol. 43, (1975), pp. 199-220.
S. W. Hawking, Phys. Rev. D, Vol. 14, (1976), pp. 2460-2473.

²⁷ S. W. Hawking, Phys. Rev. D, Vol. 14, (1976), pp. 2460-2473.

²⁸ P. F. Schewe and B. Stein, Physic News Update, The American Institute of Physics Bulletin of Physics News, Number 494, July 17, (2000). A. Allahverdyan and T. Nieuwenhuizen, Phys. Rev. Lett., Vol. 85, No. 9, August 28, (2000), pp. 1799-1802.

²⁹ M. A. Seeds, Foundations of Astronomy, 1st Edition, Brooks/Cole, Pacific Grove, CA, (1980).
Sky and Telescope Magazine, Feb. (1978), p. 113.

³⁰ P. W. Milonni, The Quantum Vacuum An Introduction to Quantum Electrodynamics, Academic Press, Inc. Boston, pp. 54-58.

The Casimir effect is predicted by Maxwell's equations and is not due to virtual particles. There is no reality to electromagnetic field zero point fluctuations and the implication that the Casimir force is an intrinsic property of space. The attractive force is due only to the interactions of the material bodies themselves. Lifshitz³¹ first developed the theory of the attractive force between two plane surfaces made of a material with a general susceptibility. The Lifshitz calculation is developed from considerations of charge and current fluctuations in a material body. These fluctuations serve as a source term for Maxwell's equations, i.e. classical fields, subject to the boundary conditions presented by the body surfaces. In the limiting case of rarefied media, the van der Waals force of interaction between individual atoms is obtained.

Thus, the *postulated* QED theory of $\frac{g}{2}$ is based on the determination of the terms of a *postulated* power series in α/π where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term. The algorithm involves scores of *postulated* Feynman diagrams corresponding to thousands of matrices with thousands of integrations per matrix requiring decades to reach a consensus on the "appropriate" *postulated* algorithm to remove the intrinsic infinities. In contrast to the QM and QED cases, the fourth quantum number arises naturally from Maxwell's equations as derived in the Electron g Factor section of Mills.³² The remarkable agreement between predictions and experiment demonstrates that $\frac{g}{2}$ may be derived in closed form from Maxwell's equations in a simple straightforward manner that yields a result with eleven figure agreement with experiment—the limit of the experimental capability of the measurement of the fundamental constants that determine α .

The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s ($s = \frac{1}{2}$; $m_s = \pm \frac{1}{2}$). Conservation of angular momentum of the

³¹ E. M. Lifshitz, "The theory of molecular attractive forces between solids", Soviet Physics, Vol. 2, No. 1, January, (1956), pp. 73-83.

S. K. Lamoreaux, "CF-1: Casimir Force", Am. J. Phys. Vol. 67, No. 10, October, (1999), p. 850-861.

³² R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2003 Edition, posted at www.blacklightpower.com.

orbitsphere permits a discrete change of its “kinetic angular momentum” ($\mathbf{r} \times m\mathbf{v}$) with respect to the field of $\frac{\hbar}{2}$, and concomitantly the “potential angular momentum” ($\mathbf{r} \times e\mathbf{A}$) must change by $-\frac{\hbar}{2}$.

The flux change, ϕ , of the orbitsphere for $r < r_n$ is determined as follows:

$$\Delta\mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \quad (1.9)$$

$$= \left[\frac{\hbar}{2} - \frac{e2\pi r A}{2\pi} \right] \hat{z} \quad (1.10)$$

$$= \left[\frac{\hbar}{2} - \frac{e\phi}{2\pi} \right] \hat{z} \quad (1.11)$$

In order that the change of angular momentum, $\Delta\mathbf{L}$, equals zero, ϕ must be $\Phi_0 = \frac{h}{2e}$, the magnetic flux quantum. Thus, to conserve angular momentum in the presence of an applied magnetic field, the orbitsphere magnetic moment can be parallel or antiparallel to an applied field as observed with the Stern-Gerlach experiment, and the flip between orientations is accompanied by the “capture” of the magnetic flux quantum by the orbitsphere. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla \cdot (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t} \left[\frac{1}{2} \mu_o \mathbf{H} \cdot \mathbf{H} \right] - \frac{\partial}{\partial t} \left[\frac{1}{2} \epsilon_o \mathbf{E} \cdot \mathbf{E} \right] - \mathbf{J} \cdot \mathbf{E} \quad (1.12)$$

Eq. (1.13) derived in the Electron g Factor section³³ gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively.

$$\Delta E_{mag}^{spin} = 2 \left(1 + \frac{\alpha}{2\pi} + \frac{2}{3} \alpha^2 \left(\frac{\alpha}{2\pi} \right) - \frac{4}{3} \left(\frac{\alpha}{2\pi} \right)^2 \right) \mu_B B \quad (1.13)$$

$$\Delta E_{mag}^{spin} = g \mu_B B \quad (1.14)$$

³³ R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2003 Edition, posted at www.blacklightpower.com.

The spin-flip transition can be considered as involving a magnetic moment of g times that of a Bohr magneton. The g factor is redesignated the fluxon g factor as opposed to the anomalous g factor. The calculated value of $\frac{g}{2}$ is 1.001 159 652 137. The experimental value³⁴ of $\frac{g}{2}$ is 1.001 159 652 188(4).

In the Quantum Electrodynamics is Purely Mathematical and Has No Basis in Reality section of this Response, the Maxwellian result (Eq. (I.13)) based in reality is contrasted with the QED algorithm of invoking virtual particles, zero point fluctuations of the vacuum, and negative energy states of the vacuum. Rather than an infinity of radically different QED models, an essential feature is that *Maxwellian solutions are unique*.

Based on the foregoing remarks, the Secret Committee's claim that quantum mechanics is the most successful theory in history is incredulous and demonstrates a fundamental lack of understanding of the technology underlying Applicant's invention.

Response to the Secret Committee's arguments that the existence of a plasma requires that only excited states rather than the formation of lower-energy states must occur

The Secret Committee argues that:

In a plasma, electrons are so energetic that they are able to escape from their respective nuclei, the very opposite of moving closer to nuclei [to] form "hydrinos". If an ordinary hydrogen atom contacts a plasma, its electron would absorb some energy from the plasma, resulting in a move to a quantum state above the ground state. This could result in an electron being completely removed, the hydrogen atom thus becoming part of the plasma.

A combustion flame emits visible atomic emission corresponding to excited atomic electronic states. Thus, according to the PTO, a combustion flame does not release net power.

³⁴ . R. S. Van Dyck, Jr., P. Schwinberg, H. Dehmelt, "New high precision comparison of electron and positron g factors", Phys. Rev. Lett., Vol. 21, (1987), p. 26-29.

In fact the opposite is true--the excited states are due to the power release. The same applies in the case of the Applicant's invention.

Prior art hydrogen plasmas sources that emit vacuum ultraviolet (VUV) are high voltage discharges, synchrotron devices, inductively coupled plasma generators³⁵, and magnetically confined plasmas. In contrast, Applicant has reported that intense VUV emission was observed at low gas temperatures (e.g. $\approx 10^3$ K) from atomic hydrogen and certain atomized elements or gaseous ions comprising catalysts of the present invention, which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV.³⁶ The presence of each of the reactants identified as providing an enthalpy of 27.2 eV formed the low applied temperature, extremely low voltage plasma in atomic hydrogen called a resonant transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. In contrast, magnesium and aluminum atoms or ions do not ionize at integer multiples of the potential energy of atomic hydrogen. $Mg(NO_3)_2$ or $Al(NO_3)_3$ did not form a plasma and caused no emission.³⁷ Anomalous afterglow durations of

³⁵ J. A. R. Samson, *Techniques of Vacuum Ultraviolet Spectroscopy*, Pied Publications, Lincoln, NE, (1980), pp. 94-179.

³⁶ R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.

R. L. Mills, P. Ray, "A Comprehensive Study of Spectra of the Bound-Free Hyperfine Levels of Novel Hydride Ion $H^-(1/2)$, Hydrogen, Nitrogen, and Air", Int. J. Hydrogen Energy, in press.

R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", J. Phys. Chem. A, submitted.

R. L. Mills, P. Ray, "Spectroscopic Characterization of Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride Ion Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Group I Catalysts", Journal of Quantitative Spectroscopy and Radiative Transfer, in press.

R. Mills, P. Ray, R. M. Mayo, "CW HI Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, in press.

H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", in press.

R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K₂CO₃-H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.

R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.

³⁷ R. L. Mills, P. Ray, "A Comprehensive Study of Spectra of the Bound-Free Hyperfine Levels of Novel Hydride Ion $H^-(1/2)$, Hydrogen, Nitrogen, and Air", Int. J. Hydrogen Energy, in press.

plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of $m \cdot 27.28 \text{ eV}$ including hydrogen-potassium mixtures were observed.³⁸ Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero.³⁹

Applicant's reaction of hydrogen to lower-energy states forms or maintains an energetic plasma. Extreme ultraviolet light as well as visible emission is emitted due to the energy release of the catalysis reaction rather than just visible light observed combustion flames.

In view of the foregoing remarks, the Secret Committee's statement that the reaction of hydrogen to lower-energy states is not consistent with the formation of a plasma, once again, demonstrates a lack of understanding of basic scientific principles.

R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", J. Phys. Chem. A, submitted.
R. L. Mills, P. Ray, "Spectroscopic Characterization of Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride Ion Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Group I Catalysts", Journal of Quantitative Spectroscopy and Radiative Transfer, in press.

³⁸ H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", in press.
R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K₂CO₃-H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.
R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.

³⁹ H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", in press.
R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K₂CO₃-H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.
R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.